# Water Efficiency Guide for Business Managers and Facility Engineers

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## Foreword

The California Department of Water Resources is committed to helping water utilities and their business, government, and institutional customers improve water use efficiency. Industrial and business water users have been increasingly responsive to water conservation programs in recent droughts, but further effort is needed to manage water use even more efficiently and involve more users in water conservation programs.

This guidebook is for industrial and commercial site managers. The guidebook offers specific measures to improve water use efficiency while sustaining production and services. These measures are appropriate for manufacturers, service businesses (hospitals, laundries, laboratories), office buildings, shopping centers, government facilities and military bases, schools, colleges, hotels, resorts, and restaurants.

Well-planned water management is often accompanied by savings of energy, wastewater treatment and toxics disposal. These long-term savings will reduce expenses and sustain the viability of the business. Managers with a thorough knowledge of their site's water use will be better able to lessen the impact of future water shortages on their operations.

This guidebook is the companion work to the American Water Works Association's ***Helping Businesses Manage Water Use—A Guide for Water Utilities***. That guidebook describes how water utilities can provide programs to help large manufacturing, business, government, and institutional customers manage water more efficiently. It is listed with other free publications in Appendix E.

To contact DWR staff members that are available to help local water agencies and their customers plan conservation programs, access the DWR website at:

http://wwwowue.water.ca.gov

We hope this publication will help business, government, and institutional water users reduce demand on water supplies by using water more efficiently.

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Of particular assistance were the members of the Industrial, Commercial, and Institutional Water Conservation Subcommittee of the American Water Works Association who envisioned this publication.

The subcommittee members recognized that water conservation programs had focused on residential water users, but had generally ignored commercial, manufacturing, and government customers. Many of these business customers use large amounts of water. Their diverse water uses were often little understood by water utility managers. This guide was developed to provide business managers and facility engineers with a comprehensive approach to water use efficiency.

Members of the Subcommittee, at the time of approval, were:

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***E. D. Yates***, California League of Food Processors, Sacramento, California

***Richard Young***, City of Palo Alto, Palo Alto, California

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# Chapter 1: Introduction

## Why Use This Guidebook?

This guidebook will help business, government, and institutional water users become more efficient water users, reduce operating costs, meet drought allotments, mitigate economic losses, and extend community water supplies.

Efficient water management for business users is analogous to energy conservation in the early 1970s. Water conservation in business is a relatively new topic. Its effectiveness will increase as new applications of water conservation measures evolve.

The ***Water Efficiency Guide for Business Managers and Facility Engineers*** is for people who design, manage, and maintain manufacturing plants, service businesses, institutions, and government installations.

This guidebook will assist:

- Manufacturers
- Service businesses, such as hospitals, hotels, restaurants, and laundries
- Medical offices and laboratories
- Office and other commercial buildings
- Government facilities and military bases
- Schools, colleges, and other institutions

This guidebook leads the manager through a step-by-step process to develop conservation programs, audit water use, determine the true value of water, identify specific energy and water conservation opportunities, seek special assistance, implement actions, evaluate the results, and publicize successful programs.

Well-planned water management is often accompanied by savings of energy, wastewater treatment, and toxic disposal. These long-term savings can reduce expenses and sustain the viability of the business. Managers with a thorough knowledge of their site's water use will be better able to lessen the impact of future water shortages on their operations.

## Commercial and Industrial Water Use

The U.S. Geological Survey periodically estimates the amount of water used for commercial and industrial purposes. This water may be supplied from public or private sources. USGS defines commercial water use as: water for motels, hotels, restaurants, office buildings, and other commercial facilities and institutions, both civilian and military. USGS defines industrial water use as: water used for industrial purposes such as fabrication, processing, washing, and cooling, and includes such industries as steel, chemical and allied products, paper and allied products, mining, and petroleum refining. USGS estimates that commercial and industrial water use totaled 36,080 million gallons per day (MGD) nationwide in 1990. This distribution is shown below.

**Commercial And Industrial Water Uses (1990)**

| Type of Water Use | Source from Public Supply (MGD) | Source from Self Supply (MGD) | Total (MGD) |
|---|---|---|---|
| Industrial | 5,190 | 22,600 | 27,790 |
| Commercial | 5,900 | 2,390 | 8,290 |
| Totals | 11,090 | 24,990 | 36,080 |

The ***Census of Manufacturers***, by the U.S. Department of Commerce, identified the largest water-using industries in the United States. Approximately 60 percent of water was used in cooling and condensing operations. Approximately 84 percent of the water used in 1983 (the most recent year for which such data was collected) was accounted for by four major industry groups:

**Largest Water-Using Industries in United States**

| Standard Industrial Classification Code (SIC) | Industry Designation Major Water Users | 1983 Water Use (billions of gallons) |
|---|---|---|
| 20 | Food & kindred products | 2,656 |
| 26 | Paper & allied products | 7,436 |
| 28 | Chemicals & allied products | 9,360 |
| 291 | Petroleum refining | 6,177 |
| 331 | Blast furnace & basic steel products | 4,990 |
| 37 | Transportation equipment | 1,011 |
| Totals: | Major water users | 31,900 |
| | Nonmajor water users | 1,935 |
| | All manufacturing industries | 33,835 |

Different industries use different amounts of water in different ways. **Water Use by Major Businesses and Industry Groups** quantifies how 8 kinds of large businesses use water in 16 categories in several U.S. cities. The most common uses are cooling, heating, cleaning and rinsing, kitchen, landscape irrigation, and processing.

## Water Use by Major Business and Industry Groups (Part 1 of 4)

*Site visit results – water use per site by major business and industry groups – gpd*

| Business or Industry | Number of Sites | Domestic Plumbing | Cooling: Cooling Towers | Cooling: Evaporative Coolers, Single Pass Cooling | Boilers |
|---|---|---|---|---|---|
| **Hospitals** | | | | | |
| Phoenix | 3 | 76,560 | 86,300 | 15,980 | 7,300 |
| Denver | 4 | 63,740 | 11,590 | 14,130 | 5,790 |
| Mesa | 2 | 35,350 | 50,250 | 11,950 | 5,000 |
| Ventura | 1 | 27,770 | 5,950 | | 750 |
| Los Angeles | 2 | 29,710 | 49,850 | | 500 |
| Average | | 46,630 | 40,790 | 8,410 | 3,870 |
| **Schools** | | | | | |
| Phoenix | 4 | 12,060 | 2,280 | 550 | 60 |
| Denver | 5 | 41,630 | 4,660 | 4,540 | |
| Average | | 26,850 | 3,470 | 2,550 | 30 |
| **Hotels** | | | | | |
| Phoenix | 4 | 34,520 | 37,010 | 1,300 | 500 |
| Denver | 2 | 46,850 | 15,240 | 28,210 | |
| Ventura | 1 | 13,130 | | | |
| Average | | 31,500 | 17,420 | 9,840 | 170 |
| **Commercial Office Buildings** | | | | | |
| Phoenix | 13 | 12,500 | 31,350 | 990 | 380 |
| Denver | 3 | 105,640 | 54,850 | 4,200 | 13,710 |
| Average | | 59,070 | 43,100 | 2,600 | 7,050 |
| **Beverage processors** | | | | | |
| Phoenix | 4 | 4,780 | 94,060 | 11,280 | 1,310 |
| Denver | 4 | 3,610 | 12,180 | 2,780 | |
| Ventura | 1 | 740 | 22,850 | | |
| Average | | 3,040 | 43,030 | 4,690 | 440 |
| **Metal finishers – PC Board manufacturers** | | | | | |
| Phoenix | 2 | 60,500 | 305,000 | | |
| Mesa | 3 | 29,700 | 209,800 | 11,530 | 6,830 |
| Average | | 45,100 | 257,400 | 5,770 | 3,420 |
| **Commercial laundry** | | | | | |
| Phoenix | 1 | 1,900 | | 4,900 | 1,500 |
| Denver | 4 | 1,830 | | 160 | 820 |
| Average | | 1,870 | 0 | 2,530 | 1,160 |
| **Food processors** | | | | | |
| Phoenix | 1 | 2,000 | 68,940 | 20,660 | 31,700 |
| Denver | 5 | 2,330 | 13,760 | 10,110 | |
| Average | | 2,170 | 41,350 | 15,390 | 15,850 |

**SOURCE:** ***AWWA Journal***, October 1992, Table 1, pages 68-69

## Water Use by Major Business and Industry Groups (Part 2 of 4)

*Site visit results – water use per site by major business and industry groups – gpd*

| Business or Industry | Process Rinses | | | |
|---|---|---|---|---|
| | Metal Plating | Electronics Fabrication | Photo. Process | Product Water, Misc. Rinses |
| **Hospitals** | | | | |
| Phoenix | | | 6,280 | |
| Denver | | | 7,890 | 8,710 |
| Mesa | | | 21,550 | 900 |
| Ventura | | | 2,510 | |
| Los Angeles | | | 11,570 | 17,280 |
| Average | 0 | 0 | 9,960 | 5,380 |
| **Schools** | | | | |
| Phoenix | | | 290 | 760 |
| Denver | | | | 4,620 |
| Average | 0 | 0 | 150 | 2,690 |
| **Hotels** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Ventura | | | | |
| Average | 0 | 0 | 0 | 0 |
| **Commercial Office Buildings** | | | | |
| Phoenix | | | 140 | |
| Denver | | | | 26,550 |
| Average | 0 | 0 | 70 | 13,280 |
| **Beverage processors** | | | | |
| Phoenix | | | | 50,110 |
| Denver | | | | 60,400 |
| Ventura | | | | 59,250 |
| Average | 0 | 0 | 0 | 56,590 |
| **Metal finishers – PC Board manufacturers** | | | | |
| Phoenix | 75,000 | 850,650 | | |
| Mesa | | 437,500 | | 3,170 |
| Average | 37,500 | 644,080 | 0 | 1,590 |
| **Commercial laundry** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Average | 0 | 0 | 0 | 0 |
| **Food processors** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Average | 0 | 0 | 0 | 0 |

**SOURCE**: ***AWWA Journal***, October 1992, Table 1, pages 68-69

## Water Use by Major Business and Industry Groups (Part 3 of 4)

*Site visit results – water use per site by major business and industry groups – gpd*

| Business or Industry | Cleaning, Sanitation: Clean-In-Place, Plant Cleaning | Cleaning, Sanitation: Sterilizers, Autoclaves | Cleaning, Sanitation: Cleaning Ingredients, Containers | Laundry | Kitchens |
|---|---|---|---|---|---|
| **Hospitals** | | | | | |
| Phoenix | | 19,000 | | 24,170 | 26,760 |
| Denver | 7,680 | 7,890 | | 19,800 | 7,280 |
| Mesa | | | | | 4,400 |
| Ventura | | 12,430 | 230 | 6,180 | 3,310 |
| Los Angeles | | 7,410 | | 800 | 10,370 |
| Average | 1,540 | 9,350 | 50 | 10,190 | 10,420 |
| **Schools** | | | | | |
| Phoenix | | | | | 700 |
| Denver | | | | 2,550 | 3,380 |
| Average | 0 | 0 | 0 | 1,280 | 2,040 |
| **Hotels** | | | | | |
| Phoenix | | | | 9,440 | 34,010 |
| Denver | 9,810 | | | 26,400 | 4,750 |
| Ventura | 1,410 | | | 11,590 | 8,820 |
| Average | 3,740 | 0 | 0 | 15,810 | 15,860 |
| **Commercial Office Buildings** | | | | | |
| Phoenix | | | 130 | | 860 |
| Denver | 80 | | | | |
| Average | 40 | 0 | 70 | 0 | 430 |
| **Beverage processors** | | | | | |
| Phoenix | 16,900 | | 8,400 | | |
| Denver | | | 11,940 | | |
| Ventura | 2,500 | | 16,860 | | |
| Average | 6,470 | 0 | 12,400 | 0 | 0 |
| **Metal finishers – PC Board manufacturers** | | | | | |
| Phoenix | | | | | 10,000 |
| Mesa | | | | | 2,000 |
| Average | 0 | 0 | 0 | 0 | 6,000 |
| **Commercial laundry** | | | | | |
| Phoenix | | | | 61,600 | |
| Denver | 240 | | | 46,550 | |
| Average | 120 | 0 | 0 | 54,080 | 0 |
| **Food processors** | | | | | |
| Phoenix | 62,550 | | | | |
| Denver | | | 30,290 | 100 | |
| Average | 31,280 | 0 | 15,150 | 50 | 0 |

**SOURCE:** ***AWWA Journal*,** October 1992, Table 1, pages 68-69

## Water Use by Major Business and Industry Groups (Part 4 of 4)

| *Site visit results – water use per site by major business and industry groups – gpd* | | | | |
|---|---|---|---|---|
| **Business or Industry** | **Water Treatment, Regeneration** | **Landscape** | **Miscellaneous** | **Total** |
| **Hospitals** | | | | |
| Phoenix | 10,760 | 41,400 | 130 | 314,640 |
| Denver | | 6,050 | | 160,550 |
| Mesa | 3,700 | 14,400 | 6,500 | 154,000 |
| Ventura | 4,750 | 8,500 | 950 | 73,330 |
| Los Angeles | 25,780 | 5,250 | 800 | 159,320 |
| Average | 9,000 | 15,120 | 1,680 | 172,390 |
| **Schools** | | | | |
| Phoenix | | 19,690 | | 36,390 |
| Denver | | 25,730 | | 87,110 |
| Average | 0 | 22,710 | 0 | 61,770 |
| **Hotels** | | | | |
| Phoenix | 1,430 | 83,530 | 400 | 202,140 |
| Denver | | | 21,810 | 153,070 |
| Ventura | | 3,990 | | 38,940 |
| Average | 480 | 29,170 | 7,400 | 131,390 |
| **Commercial Office Buildings** | | | | |
| Phoenix | 2,310 | 7,200 | 70 | 55,930 |
| Denver | | 56,500 | | 261,530 |
| Average | 1,160 | 31,850 | 40 | 158,760 |
| **Beverage processors** | | | | |
| Phoenix | 7,630 | 2,750 | | 197,220 |
| Denver | | 1,550 | 15,940 | 108,400 |
| Ventura | 1,000 | | 8,600 | 111,800 |
| Average | 2,880 | 1,430 | 8,180 | 139,150 |
| **Metal finishers – PC Board manufacturers** | | | | |
| Phoenix | 300,000 | 15,000 | | 1,616,150 |
| Mesa | 160,270 | 6,330 | 3,330 | 870,460 |
| Average | 230,140 | 10,670 | 1,670 | 1,243,340 |
| **Commercial laundry** | | | | |
| Phoenix | 6,300 | | 100 | 76,300 |
| Denver | | | 2,250 | 51,850 |
| Average | 3,150 | 0 | 1,180 | 64,090 |
| **Food processors** | | | | |
| Phoenix | 5,600 | 1,000 | 3,100 | 195,550 |
| Denver | | 10 | 14,940 | 71,540 |
| Average | 2,800 | 510 | 9,020 | 133,570 |

**SOURCE:** ***AWWA Journal*****,** October 1992, Table 1, pages 68-69

## Potential Water Savings

Studies in San Jose, Phoenix, and Boston demonstrated significant water savings for specific business, government, and institutional customers. Collectively, water utilities have produced over 200 case studies of business sites.

The City of San Jose studied 15 industrial sites that implemented water efficiency measures between 1975 and 1989. Actual water savings per site ranged from 2 million gallons per year to 470 million gallons per year and a reduction of 25 to 90 percent of previous use. The 15 sites collectively saved over a billion gallons of water per year, worth $2 million per year in water, energy, and sewer costs. Payback periods for the conservation measures were usually less than one year.

The variety of conservation measures identified in the San Jose study are shown on page 8, **Water Conservation Measures Implemented at San Jose Case Study Companies.**

In 1987, the City of Phoenix established its comprehensive Industrial, Business, and Government Water Conservation Program. Since then, the City has conducted some 80 site visits and audits. The potential water savings at these sites was over 2 billion gallons per year.

The potential savings from site visits in four U.S. cities are quantified in the table, **Projected Water Savings at Commercial and Industrial Sites** on pages 11-12. These measures can be applied to many types of facilities. More specific information is presented in Chapter 4 examples.

**Common Units of Water**

1 cubic foot = 7.48 gallons
325,851 gallons = 1 acre-foot
1 million gallons per day = 3.07 acre-feet per day

## Water Management Goals for Business Managers and Facility Engineers

Increasing water costs and fees for wastewater discharge, more stringent wastewater pretreatment requirements, and water supply restrictions impose challenges on business managers and facility engineers. They are expected to continue production and improve the effectiveness of the facility. The safety and health of employees, customers, and residents must be maintained.

These challenges are recognized in this guidebook. By identifying and acknowledging the regulatory constraints at the beginning, this guidebook alerts site managers to undesirable surprises.

# Water Conservation Measures Implemented at San Jose Case Study Companies

| Company / Conservation Measure | Electronics Manufacturing Industry | | | | | | | | | | Metal Finishing Industry | | Paper Reprocessing Industry | | Food Processing Industry |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Advanced Micro Devices | Excel | HP | Intel | IBM | International Microelectronic Products | National Semiconductor | Spectra Diode Laboratories | Tandem Computers | Xerox | Dyna-Craft | Hi Density | California Paperboard Corporation | Container Corporation of America | Gangi Bros. |
| Monitoring | X | X | X | | | X | X | X | X | X | | X | | | X |
| Employee Education | X | | | | | | X | | X | X | | X | | | X |
| Recycling | | | | | | | X | | | | | X | X | X | X |
| Recycling with Advanced Treatment | | | X | | | | | | | | | | | | |
| Reuse | | X | X | | X | X | X | | X | | | | X | | X |
| Cooling Tower (Water Recirculation) | | X | | X | X | X | | | X | X | | | | X | X |
| Cooling Water Ozonation | | X | | X | | | | | X | X | | | | | |
| Air Cooling | | | | | | | | X | | | | | | | |
| Equipment Modification | X | | | | X | X | X | X | | | X | | | | X |
| Equipment Selection | | | | | | | | | | | | | | X | |
| Process Optimization | X | X | | | | | | | | | | | | | X |
| Closed-Loop System | | | | | | | | X | X | | | | | | |
| Improved irrigation | X | X | | | X | | X | X | X | X | | | | | |
| Landscape Modification | | | | | X | | | | X | | | | | | |
| Low-Flow Plumbing | | | | | X | | | | X | | | | | | |

**SOURCE:** ***Case Studies of Industrial Water Conservation in the San Jose Area***, February 1990, Table I, page 3

## Projected Water Savings at Commercial and Industrial Sites (Part 1 of 4)

| Business or Industry | Number of Facilities | Domestic | Cooling and Heating: Cooling Towers | Cooling and Heating: Other Cooling Uses | Cooling and Heating: Boilers |
|---|---|---|---|---|---|
| | | *Projected water savings per site--gpd* | | | |
| **Hospitals** | | | | | |
| Phoenix | 3 | 14,935 | | | 640 |
| Denver | 4 | 30,710 | 590 | 12,430 | |
| Ventura | 1 | 4,990 | | | |
| Los Angeles | 2 | 6,175 | 14,495 | | |
| Average | | 14,200 | 3,770 | 3,110 | 160 |
| **Schools** | | | | | |
| Phoenix | 4 | 5,715 | 345 | | |
| Denver | 5 | 7,320 | 95 | 3,675 | |
| Average | | 6,520 | 220 | 1,840 | 0 |
| **Hotels** | | | | | |
| Phoenix | 4 | 3,650 | 4,925 | | |
| Denver | 2 | 6,315 | 9,720 | 16,710 | |
| Ventura | 1 | 1,025 | | | |
| Average | | 3,660 | 4,880 | 5,570 | 0 |
| **Commercial Office Buildings** | | | | | |
| Phoenix | 13 | 2,410 | 5,400 | 65 | |
| Denver | 3 | 54,195 | 26,640 | 4,200 | |
| Average | | 28,300 | 16,020 | 2,130 | 0 |
| **Beverage Processors** | | | | | |
| Phoenix | 4 | 585 | 31,210 | | |
| Denver | 4 | 2,120 | 2,200 | 2,380 | |
| Ventura | 1 | 80 | 5,340 | | |
| Average | | 930 | 12,920 | 790 | 0 |
| **Metal finishers- PC board manufacturers** | | | | | |
| Phoenix | 2 | 6,000 | | | |
| **Commercial laundry** | | | | | |
| Phoenix | 1 | 300 | | | |
| Denver | 4 | 755 | | | |
| Average | | 530 | 0 | 0 | 0 |
| **Food processors** | | | | | |
| Phoenix | 1 | 555 | 11,510 | | |
| Denver | 5 | 1,025 | 1,080 | 9,795 | |
| Average | | 790 | 6,300 | 4,900 | 0 |

**SOURCE:** ***AWWA Journal***, October 1992, Table 2, pages 70-71

## Projected Water Savings at Commercial and Industrial Sites (Part 2 of 4)

| Projected water savings per site--gpd | | | | |
|---|---|---|---|---|
| | | Process Rinses | | |
| Business Or Industry | Metal Finishers | Electronics Fabrication | Photo Processing | Other |
| **Hospitals** | | | | |
| Phoenix | | | | 11,300 |
| Denver | | | | |
| Ventura | | | | |
| Los Angeles | | | 6,260 | |
| Average | 0 | 0 | 1,570 | 2,830 |
| **Schools** | | | | |
| Phoenix | | | 75 | |
| Denver | | | | |
| Average | 0 | 0 | 40 | 0 |
| **Hotels** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Ventura | | | | |
| Average | 0 | 0 | 0 | 0 |
| **Commercial Office Buildings** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Average | 0 | 0 | 0 | 0 |
| **Beverage Processors** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Ventura | | | | |
| Average | 0 | 0 | 0 | 0 |
| **Metal finishers-** | | | | |
| **PC board manufacturers** | | | | |
| Phoenix | 37,500 | 73,000 | | |
| **Commercial Laundry** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Average | 0 | 0 | 0 | 0 |
| **Food processors** | | | | |
| Phoenix | | | | |
| Denver | | | | |
| Average | 0 | 0 | 0 | 0 |

**SOURCE:** ***AWWA Journal***, October 1992, Table 2, pages 70-71

## Projected Water Savings at Commercial and Industrial Sites (Part 3 of 4)

*Projected water savings per site--gpd*

| Business or Industry | Cleaning, Sanitation: Clean-in-Place Plant Cleaning | Cleaning, Sanitation: Sterilizers, Autoclaves | Cleaning, Sanitation: Cleaning Ingredient Containers | Laundry | Kitchen |
|---|---|---|---|---|---|
| **Hospitals** | | | | | |
| Phoenix | | | | | 4,455 |
| Denver | 1,300 | | | 17,875 | 1,420 |
| Ventura | | | | 3,000 | |
| Los Angeles | | 3,150 | | | 765 |
| Average | 330 | 790 | 0 | 5,220 | 1,660 |
| **Schools** | | | | | |
| Phoenix | | | | | 895 |
| Denver | | | | | 895 |
| Average | 0 | 0 | 0 | 0 | 900 |
| **Hotels** | | | | | |
| Phoenix | | | | | 16,625 |
| Denver | 4,925 | | | 5,670 | 2,230 |
| Ventura | | | | 2,700 | 2,210 |
| Average | 1,640 | 0 | 0 | 2,790 | 7,020 |
| **Commercial Office Buildings** | | | | | |
| Phoenix | | | | | 190 |
| Denver | 20 | | | | 340 |
| Average | 10 | 0 | 0 | 0 | 270 |
| **Beverage Processors** | | | | | |
| Phoenix | | | 5,755 | | |
| Denver | 1,040 | | 2,225 | | |
| Ventura | 940 | | | | |
| Average | 660 | 0 | 2,660 | 0 | 0 |
| **Metal finishers-PC board manufacturers** | | | | | |
| Phoenix | | | | | 2,500 |
| **Commercial Laundry** | | | | | |
| Phoenix | | | | 27,400 | |
| Denver | 60 | | | 6,100 | |
| Average | 30 | 0 | 0 | 16,750 | 0 |
| **Food processors** | | | | | |
| Phoenix | | | | | |
| Denver | 6,010 | | 2,180 | | |
| Average | 3,010 | 0 | 1,090 | 0 | 0 |

**SOURCE**: ***AWWA Journal***, October 1992, Table 2, pages 70-71

## Projected Water Savings at Commercial and Industrial Sites
## (Part 4 of 4)

| Business or Industry | Water Purification Regeneration | Landscape | Misc. | Total Avg -gpd | Total Percent |
|---|---|---|---|---|---|
| *Projected water savings per site--gpd* | | | | | |
| **Hospitals** | | | | | |
| Phoenix | 2,835 | 6,515 | | 40,680 | 13 |
| Denver | | 3,035 | | 67,360 | 42 |
| Ventura | | | | 7,990 | 11 |
| Los Angeles | 1,600 | | | 32,445 | 20 |
| Average | 1,110 | 2,390 | 0 | 37,140 | 22 |
| **Schools** | | | | | |
| Phoenix | | 600 | | 7,630 | 21 |
| Denver | | 4,935 | 1,085 | 18,005 | 21 |
| Average | 0 | 2,770 | 540 | 12,830 | 21 |
| **Hotels** | | | | | |
| Phoenix | | 75 | | 25,275 | 13 |
| Denver | | | 960 | 46,530 | 30 |
| Ventura | | | | 5,935 | 15 |
| Average | 0 | 30 | 320 | 25,910 | 20 |
| **Commercial Office Buildings** | | | | | |
| Phoenix | | 1,000 | 140 | 9,205 | 16 |
| Denver | | 31,840 | 235 | 117,470 | 45 |
| Average | 0 | 16,420 | 190 | 63,340 | 40 |
| **Beverage Processors** | | | | | |
| Phoenix | 270 | | 4,520 | 42,340 | 21 |
| Denver | | 255 | 1,010 | 11,230 | 10 |
| Ventura | 430 | | 5,175 | 11,965 | 11 |
| Average | 230 | 90 | 3,570 | 21,850 | 16 |
| **Metal finishers- PC board manufacturers** | | | | | |
| Phoenix | 114,670 | 5,000 | | 238,670 | 15 |
| **Commercial Laundry** | | | | | |
| Phoenix | 2,400 | | | 30,100 | 39 |
| Denver | | | 270 | 7,185 | 14 |
| Average | 1,200 | 0 | 140 | 18,650 | 29 |
| **Food processors** | | | | | |
| Phoenix | | | 17,615 | 29,680 | 15 |
| Denver | | | 1,545 | 21,635 | 30 |
| Average | 0 | 0 | 9,580 | 25,670 | 19 |

**Source:** ***AWWA Journal***, October 1992, Table 2, pages 70-71

Water efficiency measures must be consistent with public health and environmental requirements, and accepted by regulatory authorities. For example:

- Changes at meat processors engaged in interstate commerce must be approved by the U.S. Department of Agriculture, Food Safety and Inspection Service.

- In California, changes at health care facilities must be approved by the Statewide Office of Health Planning and Development and the Department of Health Services Licensing and Certification.
- Local health agency and plumbing codes must be followed.

With these requirements acknowledged, consider the following reasons for implementing water management measures:

1. Sustain production and preserve jobs with new water use objectives:

    - Recycle water on-site. Match the quality of water with the quality required by the use. High-quality water should be applied only to uses that can be justified. Example: Industrial wastewater may be recycled in the same process or treated and applied to other processes at the same site.

    - Use treated municipal and industrial wastewater instead of potable supplies for landscape irrigation, dust control, and cooling water.

2. Identify and evaluate specific water management alternatives for improved water use efficiency:

    - Understand why and how water is used in the various processes and equipment in the facility. Know the different thermal and chemical requirements of these water uses.

    - Identify conservation measures that will reduce water use while sustaining production. Loss of production will adversely impact business and the community.

    - Conserve water and energy together, particularly when the energy is heat. Recycling warm water saves energy.

    - Reduce wastewater and toxic waste disposal. Efficient water management will decrease wastewater volume and require fewer chemicals that may produce toxic by-products. When considered together, conservation becomes more cost effective.

3. Save money, energy, and water for years:

    - Anticipate increased utility rates for water and wastewater service. Ask your water and wastewater utilities for projections of future rates. If you pump water from your own wells, anticipate declining water tables and increased energy cost for pumping.

- Encourage water and wastewater utilities to provide rebates and other financial assistance to offset part of the initial cost of implementing conservation measures.

- Use the site audit analysis and water conservation plan to justify requests for reductions in wastewater charges. The audit can also document water requirements needed for future production increases.

- Realize cost reductions due to improved water use efficiency. After the initial payback period, soundly conceived and implemented conservation measures will save money throughout the life of the measure. The savings will increase as utility rates for water, energy, and wastewater discharge rise. As fees and utility rates increase, businesses implementing conservation measures will have a competitive advantage over firms that ignore conservation opportunities.

# Chapter 2: Steps for a Successful Water Conservation Program

The following steps in this chapter will guide you in developing a successful water conservation program for your facility.

**<u>Steps for a Successful Water Conservation Program</u>**

| | |
|---|---|
| Step 1 | Line Up Support and Resources |
| Step 2 | Take Immediate Action: Do the Obvious First |
| Step 3 | Conduct a Water Audit to Assess Current Water Uses and Costs |
| Step 4 | Identify Water Management Opportunities in Plant and Equipment |
| Step 5 | Prepare an Action Plan |
| Step 6 | Implement Water Management Measures |
| Step 7 | Publicize Success |

## <u>Step 1—Line Up Support and Resources</u>

### Get the Commitment of Top Management

Top management needs to support water conservation programs. Initially, water conservation programs may require up-front funding and may influence many operations. Management will be encouraged when it realizes that valuable energy savings and wastewater discharge reductions may be achieved with water savings. Energy and water conservation values should be used as decision criteria for management policies.

Reasons company executives should support conservation include:

1. <u>Savings</u>: Investment in efficient long-term water management can reduce operations costs, such as: water supply, wastewater disposal fees, water softening, chemical treatment, reverse osmosis, pretreatment of wastewater, and disposal of aqueous toxic waste.

2. <u>Production</u>: Improved water use efficiency may make additional water available for increased production without purchasing additional water supplies.

3. <u>Drought</u>: During drought periods, water utilities may allow firms demonstrating efficient water use to maintain their water use amounts.

4. <u>Public Relations</u>: Successful water conservation programs can enhance a company's public image.

### Important Management Actions

The following are important actions management should implement:

1. Establish a policy supporting efficient water management.

2. Emphasize the importance of water conservation to employees.

3. Establish goals and priorities.

4. Designate a conservation manager responsible for all water use, energy use, wastewater discharge, toxics disposal, and compliance with water allotments. The conservation manager should:

   - Review the effectiveness of existing conservation programs for possible improvements.
   - Evaluate institutional and regulatory constraints.
   - Establish a budget and procure funding.
   - Seek outside funding, if necessary.
   - Establish a schedule for water audits.
   - Establish criteria for implementing water and energy conservation measures.
   - Prepare a conservation action plan.
   - Implement water-conserving measures and install water-efficient equipment.
   - Establish a system for employees to notify the proper parties about leaks, drippy faucets, broken sprinklers, or other occurrences of water waste.
   - Evaluate the program and make modifications to meet goals and priorities.

5. Make each organizational or process unit responsible for the costs of the water, energy, chemicals, and resources used, and any toxic disposal needs created.

6. Support the conservation manager.

7. Provide continued funding.

8. Direct employee education and encourage cooperation.

9. Recognize achievements in conservation.

### Get Employee Participation

The importance of employee awareness and cooperation in the program cannot be overstated. It deserves recognition from the top.

1. Begin the awareness program with a letter to all employees from the head of the company, such as CEO, president, owner, mayor, city manager, governor, or chief administrator. The letter should describe the conservation policy, designate a conservation manager, show full support of the plan, and invite feedback.

2. Establish a water education program for employees. Provide background information about water conservation and its implications for company operations:

   - Describe the conservation program developed for the company.

   - Stress the need for individual responsibility as part of a team effort to achieve conservation goals.

   - Ask for and promote suggestions from employees at all levels. Recognize and reward people who submit water-saving ideas.

   - Incorporate water conservation into employee training programs.

   - Perform the next two tasks after water uses are identified and efficiency measures are evaluated (STEP 4, page 27):

     —*Describe the amount of water used by specific operations and the amount of water and energy that can be saved by water-conserving actions.*

     — *Publish and distribute new procedures to operators and supervisors. Amend operating guides and manuals that govern day-to-day operations to include water-saving measures.*

   - Use bulletins, electronic mail, newsletters, and paycheck stuffers to communicate policies, programs, ideas, announcements, progress reports, and news of special achievements.

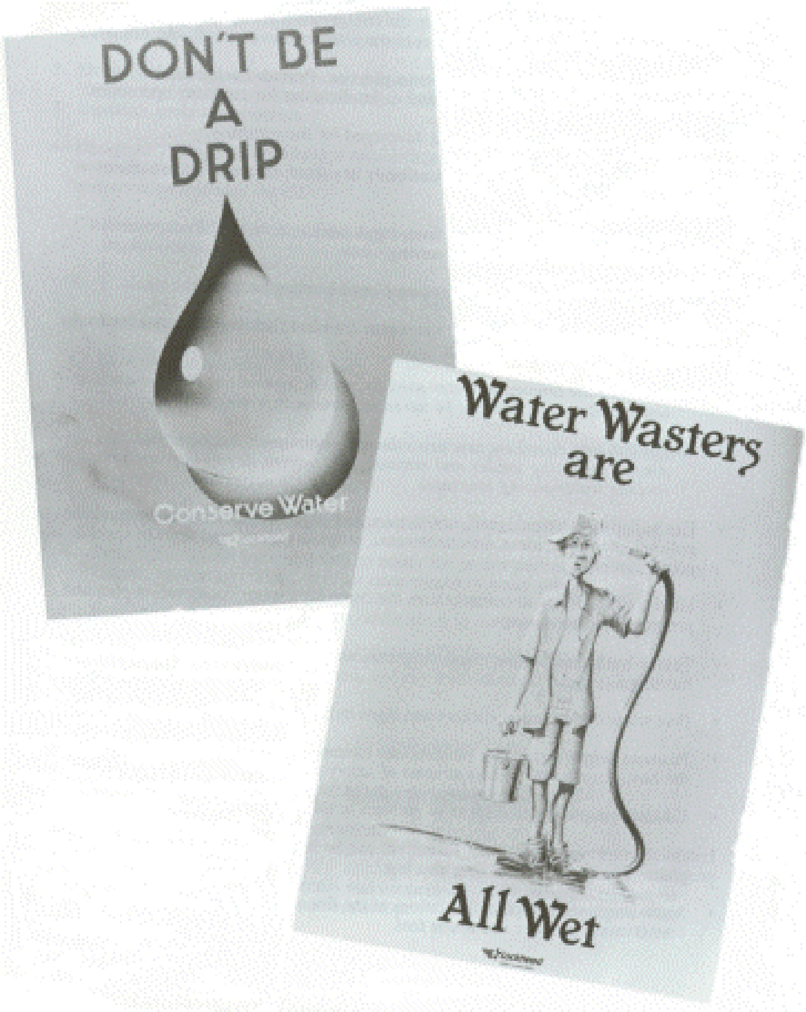
   - Hold staff meetings to communicate the company's water conservation plan and progress in water savings.

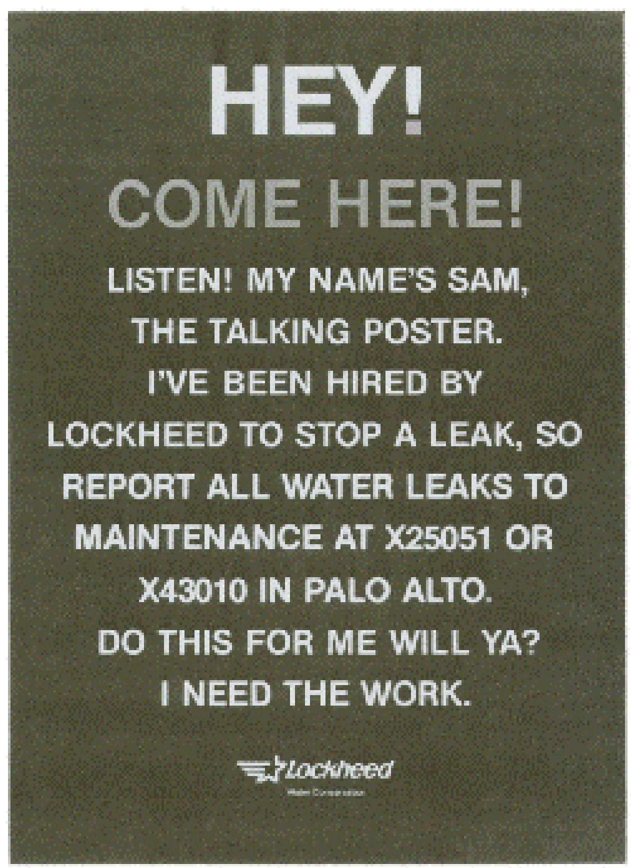
   - Take advantage of audio-visual programs, and use outside speakers for employee meetings.

   - Post water conservation stickers and signs in bathrooms, kitchens, and cafeterias.

   - Promote slogan and poster contest (see examples on page 18). Display the best slogans and posters at areas of heavy water use.

   - Educate people <u>not</u> to dispose of garbage in toilets.


DON'T BE
A
DRIP
Conserve Water
Water Wasters
are
All Wet


HEY!
COME HERE!
LISTEN! MY NAME'S SAM,
THE TALKING POSTER.
I'VE BEEN HIRED BY
LOCKHEED TO STOP A LEAK, SO
REPORT ALL WATER LEAKS TO
MAINTENANCE AT X25051 OR
X43010 IN PALO ALTO.
DO THIS FOR ME WILL YA?
I NEED THE WORK.
Lockheed

3. Establish employee incentives. Incentives can be important catalysts to an education program. Create a "water-saving idea box":

- Show employees graphic illustrations of the financial savings available from conservation in water and sewer fees.
- Promote efficient water, energy, and wastewater management as an important way to express environmental responsibility.
- Consider motivating employees by rewarding them with percentage of the first year's direct savings.
- Allocate water use to individual departments to increase the water conservation spirit. Each department's cost savings from decreased water use could be channeled toward increased benefits for that department.
- Organize and stimulate competition between shifts.
- Consider all suggestions seriously.
- Implement effective ideas.
- Reinforce team effort by sharing and reporting the results through a variety of company media.

4. Graphically display the facility's actual water use results compared with the goal for the month.

5. Publicize water supply issues highlighting the importance of our precious water resources.

6. Develop an employee education program that will help employees save water at home:

- Offer home water-saving devices to employees free or at cost. Sponsor demonstrations that show how to water landscapes efficiently, plant seeds for water-thrifty plants, install low-flow plumbing fixtures, and improve water-use habits. Device manufacturers, hardware stores, or your water utility may help.
- Set up a water conservation display every month in the employee cafeteria. Highlight different aspects of water use at the work site and at home.
- Distribute home water conservation booklets.

### Get Outside Help

Trade associations and water, energy, and wastewater utilities should be consulted. They will often have ideas or resources to develop a successful, cost-effective program.

Participate in the local "Water Conservation Advisory Committee for Business" sponsored by local water utilities. If one does not currently exist, help your water utility establish one. These committees offer excellent opportunities to make contacts for technical information and funding.

Water and wastewater utilities are interested in helping customers conserve water. They can provide information, contacts with other industries, and advice. Water suppliers may even be able to help conduct leak detection programs or water audits of facilities. Larger utilities may have funding, rate reductions, or other financial incentives for conservation measures that require capital expenditures.

Some major energy utilities provide engineers to conduct energy audits at business and government sites and make recommendations for cost-effective conservation measures. Rebates may be available to customers to reduce the cost of implementing those measures. When these measures also save water, such as recycling hot water, rebates can help offset the cost of water conservation.

Work with wastewater utilities and wastewater discharge regulators. Conservation measures will change wastewater discharge volume and chemistry. Typically, the volume of waste fluids will be reduced, and the total mass of suspended and dissolved solids will remain the same, resulting in increased concentrations. Other chemical characteristics, such as pH, may change. The increased concentrations may alter a facility's ability to meet National Pollution Discharge Elimination System and/or State Pollution Discharge Elimination System permit requirements.

Ask wastewater regulators to recognize conservation efforts by amending your wastewater discharge permit. For instance, there are more than 20,000 cooling towers in California. Many cooling towers could double or triple water use efficiencies and reduce waste discharge volume. Limits on discharge concentrations of total dissolved solids (TDS) may currently prohibit some cooling tower operators from implementing these conservation measures. Amended discharge limits could address total mass of solids instead of concentration levels. Mass-based discharge limits may be accepted on a permanent basis.

## Step 2—Take Immediate Action: Do the Obvious First

### Look for Leaks Routinely and Fix Them Immediately

Frequently walk through the facility during working hours to locate broken pipes, leaks, faulty hoses, and the like. Some leaks can be found only during shutdown by checking meters. Encourage employees to report all leaks, including leaky toilets and faucets. Fix all the leaks promptly.

Check thoroughly:

1. Kitchen, cafeteria, laundry, dish washing, washdown hoses, and janitor closets.

2. Research and laboratory areas.

3. All bathrooms on a regularly scheduled basis. In tank toilets, conduct dye leak tests. To prevent leaks, turn off the water supply and close off bathrooms in unused areas.

4. Eye-wash stations and water fountains.

5. Process plumbing, such as pump packing, tank overflow valves, and stream traps.

### Eliminate Waste and Unnecessary Uses

Start water-conserving practices that residential users have used during droughts, such as reduced vehicle washing. If the water use activity is continued with recycled or reclaimed water, post signs visible to employees and the public to publicize this information.

Install timers to automatically shut off unnecessary flows after work hours have ended.

Eliminate hot water where unnecessary. This saves water people let run while waiting for hot water. To be effective, post signs that only cold water is available.

Implement simple ways to conserve even small amounts of water. This attention to water management detail heightens awareness, shows company commitment, and sets an example for employees, clients, and visitors.

## Step 3—Conduct a Water Audit to Assess Current Water Uses and Costs

| **Water Inventory Actions** |
| --- |
| Water Audit Action 1 - Preparation |
| Water Audit Action 2 - Survey the Facility |
| Water Audit Action 3 - Determine the True Costs of Water Use |

### Conduct a Step-by-Step Water Audit

A thorough understanding of the site's water uses is needed to identify potential water efficiency opportunities. Since water uses vary greatly from one type of business or institution to another and from site to site, each individual site needs a water audit.

### Water Audit Defined

A water audit is the process that identifies the quantities, characteristics, and uses of all water on the site (see **Water Inventory/Audit Process** on page 21). Important water characteristics include flow rate (gallons per minute), flow direction, temperature, and pertinent chemical quality. From the water audit, a map, called a water balance diagram, (see **Sample Water Balance Diagram** on page 22) is produced identifying all water uses from source through the on-site processes, machines, buildings, and landscape irrigation to evaporation and wastewater discharge. To account for all water uses in the water balance, the total inflow should equal the total outflow plus consumption, irrigation and evaporation.

### Water Audit Action 1—Preparation

Thorough preparation will maximize the efficiency of your water audit. Collect all information regarding water use in the facility and identify people familiar with the operation. The information should include:

1. Exact location of site included in the audit.

## Water Inventory/Audit Process

The following water audit actions lead to cost-effective water efficiency measures.

**Water Audit Action 1-**
**Preparation**

1. Identify People Familiar with Operations
2. Gather Records:
   - Utility Records
   - Plumbing Diagrams
3. Understand the Site:
   - Alternate Water Supply Sources
   - Number of Employees
   - Work Shift Schedules
   - Preliminary List of Water Using Equipment & Processes
   - Sanitary Facilities
   - Outdoor Water Use

Prior Energy & Water Use Surveys

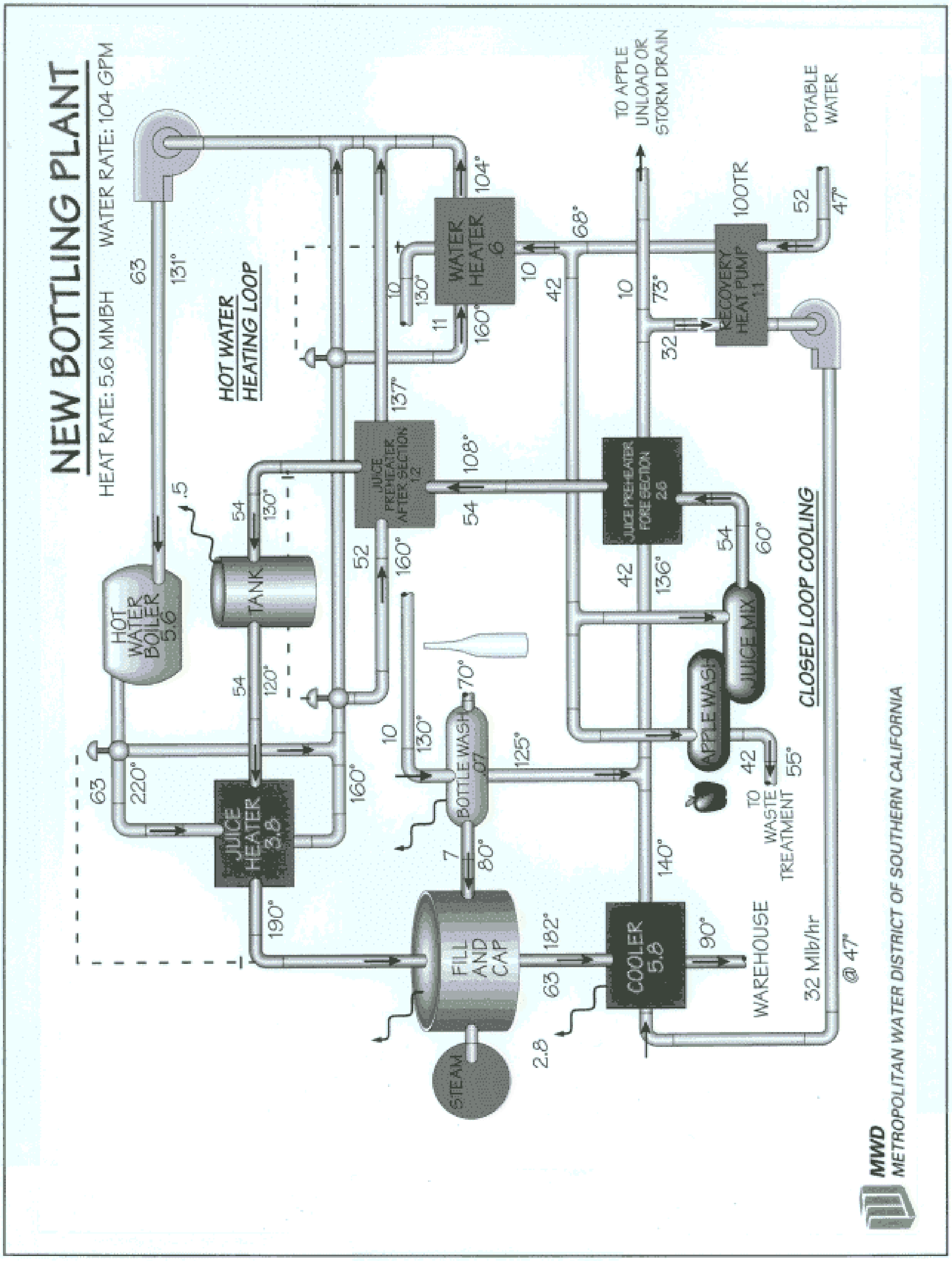
**Water Audit Action 2-**
**Survey the Facility**

1. Identify All Water-Using Equipment & Processes
2. Find Leaks
3. Confirm Operations
4. Confirm Water Plumbing Diagrams
5. Quantify Water Flow & Quality Needs
6. Key Target Areas:
   - Cooling & Heating Systems
     - Boilers, Hot Water & Steam
     - Evaporative Cooling Systems
     - Single-Pass Cooling
     - Equipment Cooling
   - Process & Equipment Use
     - Rinsing & Cleaning
     - Plating and Metal Finishing
     - Photo and X-ray Processing
     - Painting
     - Dyeing
     - Applying Degraded Water
   - Sanitary, Kitchen & Domestic Use
     - Medical Care Facilities
     - Maintenance Operations
     - Landscaping Irrigation

**Water Audit Action 3-**
**Determine the True Costs of Water Use**

1. Identify Other Expenses of Using Water
2. Calculate Dollar Savings Resulting from Reduced Water Use
   - Water Purchased from Utilities
   - Preparing Water for Use
   - Energy
   - Pretreating Effluent
   - Wastewater Discharge Fees
3. Calculate Unit Costs of Using Water

## Sample Water Balance Diagram




23

2. Physical size of the facilities, including the number of buildings, with floor space in square feet.

3. Plumbing drawings and riser diagrams.

4. Contact people names and telephone numbers.

5. Specific services or products produced at the site:

   - For service establishments, such as restaurants, hotels, hospitals, military bases, and schools, identify the number of meals served, guest rooms, and occupancy data.

   - For manufacturing sites, identify the amount of water used per quantity of product produced (that is, gallons per ton of product or gallons per gross of widgets).

6. Operating schedule of the facility, number of employees per shift, maintenance shifts, and other operating information.

7. A water use profile (total water use and water use per unit of product) graphed by month.

8. Names of energy, water, and wastewater utilities. Copies of bills for the twelve-month audit period. Copies of the billing rates for the next two years.

9. Lists of water-using equipment with manufacturers' recommended flow requirements.

10. Inventories of sanitary fixtures.

11. Outdoor water use.

12. Prior water and energy surveys.

13. Water delivery records from water meters, tank trucks, or your own wells. Accurate water meters are essential to conduct a valid water audit. Source water meters indicate the amount of water supplied to the site. Submeters indicate water use for specific processes and individual buildings within the site. The following meter information is necessary before beginning an audit:

    - Location map identifying each water meter.

    - Locations of all water supply meters recording deliveries from utilities, wells, and other sources.

    - Locations of all on-site process and building meters.

14. Water readings for all meters for at least 13 months to yield 12 months of consumption data. Associate the readings with the proper meter.

15. Calibration test results for all meters to adjust past meter readings to reflect actual water use.

If significant water efficiency practices have not been attempted in the past, experienced help may be needed. To identify, evaluate, and implement management opportunities experienced staff and suggestions may be available from:

- other units of your own organization;
- consultants who understand your processes; and
- electric, gas, wastewater, and water utilities.

### Water Audit Action 2—Survey the Facility

Conduct a walk-through survey with production people for specific areas to understand how water is used within the facility. Use direct observation and measurements. Identify and list all pieces of equipment that use water. Equipment operators may have important first-hand information.

1. Record hours of operation of each water-using process or piece of equipment. Recognize water piping, particularly in areas of old equipment, to aid in identifying water uses. Note when equipment has two modes of water use. For example, air compressors may use water for cooling and sealing.

2. Identify water flow and quality as needed for each use:

   - temperature;
   - chemistry, such as pH, TDS, or conductivity; and
   - organic loading.

   This information will be needed to determine if discharges from one use can be used as a potential supply for a different application.

3. Measure the amount of water use. The most direct way to measure flow rates is with a bucket (or plastic bag) and a stopwatch. Install meters on major water-using processes to record the quantity of water used.

   (For accurate measurements, size the meter for the actual flow rather than the pipe size. Use temporary strap-on meters to determine the approximate flow. Then, the correct size of the displacement meter can be determined before installation. Temporary meters will also indicate whether it will be cost effective to install permanent meters. Refer to American Water Works Association manuals ***Flowmeters in Water Supply M33*** *and* ***Water Meters—Selection, Installation, Testing, and Maintenance M6.*** Obtain these publications from AWWA, 6666 West Quincy Avenue, Denver, Colorado 80235; telephone 1-800-926-7337 or website www.awwa.org).

Some of the benefits of accurate metering are:

- Helps operating personnel become familiar with water use for all operations.

- Indicates whether equipment uses water when it is not needed. (In some rinses, water is continuously running, even if the need is occasional.)

  —*Be sure to check quantity and quality of water specified within the equipment operating manual. Equipment is sometimes operated with higher water flows than called for by manufacturers' specifications. Have qualified engineers review specifications and adjust flows accordingly. Also investigate whether processes can still operate properly with further reductions in water flow. Remember to record flow rates before and after changes to evaluate the effects.*

  —*Read water meters regularly and compare actual water use to the facility's water reduction goal. After initially determining daily use rates, the frequency of the readings should be adjusted to be consistent with the volume of water used, the cost of reading the meters, and potential excessive use fees. For example, large water users (more than 50,000 gallons per day) should continue to read meters daily. Commercial businesses using water only for sanitary purposes might read meters biweekly or monthly. Instructions on how to read your water meter are in Appendix A. Appendix B is a sample chart on which you can plot your usage.*

4. Identify flow and quality of wastewater resulting from each use.

5. Include internally-generated fluids in the water audit. Water may be generated as a by-product of processing raw materials, such as fruits. Determine the quantity and quality of these fluids. Determine whether there are potential on-site uses for these fluids such as fluming or cooling.

6. Use the results of the survey to prepare a map called a water balance diagram (see **Sample Water Balance Diagram**) to depict all water uses from source through the on-site processes, machines, and buildings to evaporation and discharge as waste.

### Water Audit Action 3—Determine the True Costs of Water Use

The cost of using water often includes other expenses besides the water utility fees. For example:

- dish washing requires water heating, cleansers, and sanitizing agents;
- steam requires treatment of boiler feed water by softening and scale inhibitors;
- cooling towers require pumping and chemicals to prevent corrosion, scaling, and pathogens;
- clean-in-place systems may pump caustic chemicals, sanitizing agents, hot water, and rinse water through closed pipes and vessels used in food processing.

Other water uses may require predisposal treatment, discharge to municipal wastewater systems, or disposal of hazardous aqueous substances. These are all components of the total costs of water use.

The objective is to calculate the dollar savings resulting from reduced water use. This requires a value for each unit of water used. One approach is to divide the total costs of water used for a year by the amount of water used. Another approach is to divide the total cost of water use for a production run by the number of units produced for that run.

As indicated earlier, the total cost of water use may consist of many components. Current prices are useful as a starting point. A more meaningful comparison will be made using the future prices which will be experienced after the efficiency measures are implemented. Some of the major elements of total costs of water are:

1. Water purchased from utilities normally has several billing components:

   - Fee = fixed charge + water use rate.

   - Dollar value per gallon or HCF (one hundred cubic feet = 748 gallons) should be included in the evaluation of potential water management measures. The fixed charge should be excluded from the analysis.

   - Seasonal cost variations should not be overlooked. Summer rates are sometimes higher than winter rates.

2. Cost of pretreating and/or additional pumping.

3. Energy cost of heating water at future rates.

4. Cost of pretreating effluent.

5. Chemical or other treatment costs:

   - treating water for process use, such as softening;
   - treating cooling tower water;
   - treating and disposing of aqueous toxic wastes; and
   - pretreating water for wastewater discharge.

6. Cost that would be paid to a wastewater treatment agency if the firm exceeded the discharge capacity stated in the firm's current sewage permit. Conservation may delay or eliminate this potential increased cost assessment.

7. Sewer fees at future rates. Note that these are often based on water consumption, dissolved solids, suspended solids, and chemical/biological oxygen demand.

8. Energy costs for pumping from wells or pumping in the plant.

These costs are added to determine the total cost of water use. The unit cost of water is calculated by dividing the total cost of water use by the total amount of water purchased and produced. The production cost of using water is the total cost of water use divided by the number of production units achieved with that amount of water.

Normally the first objective would be to reduce consumption of the most expensive water use.

## Step 4—Identify Water Management Opportunities in Plant and Equipment

Step four describes general approaches to identifying water-savings opportunities (listed below). These approaches can be applied to the water uses at any site. Specific measures are described in Chapter 3, Target Areas for Potential Water Savings.

**General Approaches to Identifying Water-Saving Opportunities**

- Use Minimum Amounts of Water to Accomplish the Task
- Recirculate Water within a Process or Group of Processes
- Reuse Water Sequentially
- Treat and Reclaim Used Water
- Displace Potable Water Supplies with Water from Non-potable Sources
- Install Meters at High-Flow Processes and Equipment

### Use Minimum Amounts of Water to Accomplish the Task

Controls and monitors can be added to most equipment. Install control systems to apply water only when it is needed.

1. Adjust measured flow to equipment according to the manufacturer's specifications, then carefully adjust flow to improve water efficiency.

2. Install flow reduction devices to maintain the specified flow. Commercially available flow control (compensating) devices hold a constant flow rate over a range of pressures.

3. High pressure accelerates flows. To avoid using higher water pressure than necessary, install pressure-reducing valves if water pressure is greater than 60 pounds per square inch.

4. Interlock solenoid valves with time clocks or power switches on equipment to control flow. The interlocked valves shut off water flow when equipment is not operating or does not need water.

5. Install temperature control valves for cooling flows.

6. Inspect all valves for improper settings, malfunctions, or leaks. Make controls tamper proof where unauthorized adjustments are likely.

7. Install and maintain limit switches on tanks to eliminate over filling.

8. Use conductivity probes to sense water quality, such as dissolved solids. Make-up water is often added to process water (for example, cooling towers or scrubbers) to reduce dissolved solids. Conductivity probes linked to control valves allow the correct amount of make-up water to be added to spent process water.

### Recirculate Water within a Process or Group of Processes

In general, process water can be divided into two categories:

1. High-quality water not seriously affected by the process. This is typified by cooling or heating water which, except for temperature, remains essentially unchanged. Chemical quality changes little within the process. All cooling and heating water should be recirculated. Allow condenser side water to cool before recirculating.

2. Low-quality water which is seriously affected by the process. In this case, investigate the installation of neutralizing tanks or other treatment. Treat water until it reaches a sufficient quality to allow it to be recirculated.

### Reuse Water Sequentially

Sequentially using water is the practice of using a given water stream for two or more processes or operations in a series before final disposal. The effluent of one process is the input for another. Treatment may or may not be necessary between each process or operation. Determine your minimum water-quality specifications for each process. A combination of reuse and treatment may be required in an optimal scheme.

### Treat and Reclaim Used Water

Continuous savings due to reduced water and sewage costs may repay the cost of reclamation systems. In some cases, the payback periods are less than a year.

High-value water, such as deionized water, can be treated and reused. For example, semiconductors are rinsed with deionized water. A sensor monitors the quality of used rinse water and actuates a valve in the drain line. The initial rinse is highly contaminated and is piped away for other uses. Successive rinses are only slightly contaminated and can be reused for further rinsing.

Suspended solids may be removed from waste flows by flocculation, dissolved air flotation, and filter systems. The filtered solids can be hauled away as non-toxic waste, and the aqueous solution can be treated and reused. Benefits are reduced wastewater solids and associated fees, water with its associated chemicals, and heat that is reclaimed.

### Displace Potable Water Supplies with Water from Nonpotable Sources

This includes reclaimed municipal water, collected rainwater, or decontaminated ground water. This may not be possible for food processors.

### Install Meters at High-Flow Processes and Equipment

Meters will help to monitor actual water use. Unexpected changes in water use may indicate leaks or malfunctions in the process. Several types of meters are available, some of which can be attached to the outside of the pipe without contacting the fluid. Before installing permanent meters, use strap-on meters to identify the pipes where flow is most important and determine the flow ranges.

## Step 5—Prepare an Action Plan

Write an Action Plan listing all planned water efficiency measures. The Action Plan should:

1. State company policy reflecting the commitment of top management. (See Chapter 2, Step. 1 of Line Up Support and Resources)

2. Quantify goals. State how much water will be saved for the entire facility and each organizational unit. Set deadlines when these goals should be achieved.

3. List all efficiency measures identified in the water audit and by employee suggestions.

4. Evaluate each efficiency measure. Fully itemize costs and benefits including capital costs, recurring costs, projected savings, and payback periods. Include secondary effects on energy consumption, treatment of water, chemical costs, creation of solid and toxic wastes, and wastewater discharge. Page30 shows a **Sample Water Efficiency Calculation**

5. Classify measures:

    - measures that are cost effective and should be implemented as soon as possible;

    - potential measures that need to be evaluated with meaningful data collected through a trial period; and

    - measures that are not cost effective but could be implemented as drought responses.

6. Identify no-cost or low-cost actions for immediate implementation. Identify the exact location of each measure by building, plumbing system, and process. Outline the specific tasks required.

7. Identify any need for engineering design.

8. Prioritize measures by water savings and cost effectiveness. Also consider applicable energy, water, wastewater, and production benefits.

## Sample Water Efficiency Calculation

The California Paperboard Corporation operates a paper processing plant in Santa Clara, California. The result of the water efficiency measures is an overall water savings of 1.3 million gallons per day.

| | |
|---|---|
| Gross Annual Savings | |
| Water recycling: | |
| • 470 million gallons per year | |
| • @ \$0.46 per 1000 gallons | \$216,200 |
| Wastewater Disposal: | |
| • 470 million gallons per year | |
| • @ 1.30 per 1000 gallons per year | \$611,000 |
| Subtotal Gross Annual Savings | \$827,200 |
| Annual Costs | |
| Amortization of installing pumps, sumps, piping, and clarifier[1] | \$ 20,100 |
| Operating and maintenance costs for labor, power, and equipment | \$ 40,000 |
| Subtotal Annual Costs | \$ 60,100 |
| Net Annual Savings | \$767,100 |

Payback Period

Time in years for savings to meet costs:

- \$ 60,100/827,200 = 0.07 years or about 4 weeks

The measures are cost effective.

**NOTE:** [1]Capital expenses of \$150,000, amortized over a design life of 20 years at 12 percent interest

9. Schedule when each specific water management measure will be implemented and used for production.

10. Identify the employee responsible for implementing each conservation measure, and continuously review the measure's performance.

11. Indicate clearly which, if any, of these measures are offset measures. Offset measures are water conservation measures required by some water utilities when additional water supplies or wastewater capacity is unavailable. The customer pays for water efficiency measures at sites it neither owns nor manages. The water saved is usually credited to the customer's water or wastewater allocation although no water is saved by the offset measure at the customer's site.

    Examples:

    —*A food processor wishes to add a new production line which will require 25,000 gallons per day of potable water and increase its discharge to the municipal sewer system by 20,000 gallons per day (gpd).*

    *If the wastewater utility is at its maximum treatment capacity, the utility may require the food processor to fund efficiency measures to reduce wastewater flows equal to the proposed 20,000 gpd increase. The food processor might fund the installation of 1.6 gallon per flush toilets at area schools and municipal buildings.*

    —*Under a different scenario with the same food processing example, let us suppose that the water utility has reached its capacity to deliver potable water in the summer canning season. The water utility requires the food processor to pay for part of the cost of extending a reclaimed wastewater distribution pipeline to a cemetery. The cemetery will then irrigate its landscape with reclaimed wastewater instead of potable water. The potable water, formerly used at the cemetery, can then be used by the food processor.*

12. Identify funding sources for specific measures that will require capital expenditure. Loans or rebates from energy or water utilities may be available.

13. Provide for evaluations and revisions. The Action Plan should state criteria for making revisions and provide a schedule when the effectiveness of measures will be reviewed.

## Step 6—Implement Water Management Measures

Follow the plan and schedule to implement efficiency measures. Make funding, staff, and resources available to those responsible for each task. Fine tune each process to maximize water use efficiency. Hold progress meetings to monitor activities and evaluate progress. Periodically evaluate the results of individual measures and the overall direction of the effort.

## Step 7—Publicize Success

Publicize the success of your program by all available means. Good publicity promotes good relations with employees, the community, and other businesses and stimulates similar water management efforts. Some examples of publicity options are: internal memos and newsletters, brochures, trade publications, news releases to local media, letters to public officials, interviews, or local radio and television talk shows. Most water utilities will help publicize good results to encourage others to develop water management programs. A good program is news, because it means more water available to the community.

Businesses with successful water management programs deserve to be recognized by the public. The public needs to be informed that the business is a socially and environmentally responsible partner in the community. The following actions can help make business publicity efforts more visible and successful:

1. Send members of the company water conservation team to community conservation seminars to share program results and glean tips from other companies' efforts.

2. Participate in the Water Conservation Advisory Committee for Business sponsored by local water utilities.

3. State savings in relevant terms such as dollars, water savings per unit of product, earnings per share, or annual consumption per household.

4. Develop displays outlining the company's water conservation results and locate the displays in public reception areas.

5. Place posters and other exhibits in public buildings and at fairs.

6. Place signs on water-thrifty landscapes to identify the types of low-water using plants and their watering needs.

7. Sponsor water conservation projects such as a public Xeriscape demonstration garden.

8. Dedicate a percentage of the water and energy savings to the community. This will encourage further resource management efforts within the facility.

9. Once the conservation plan has shown significant water savings, develop a comprehensive public relations program, including interviews with local radio and television stations, and newspapers about the company's water management successes.

10. Sponsor water conservation contests in schools. For example, ask students to create posters to be displayed in the community and at the company work sites.

## Chapter 3: Target Areas for Potential Water Savings

In Chapter 2, Step 4 presented six general approaches to identifying water-saving opportunities. All of these approaches can be applied to a variety of water uses in different industries and processes. This chapter describes the major water uses, called "target areas for water savings," which are listed below.

For each of the target areas, this guidebook lists some of the more common water and energy management measures available with existing technology. Many of these measures can be applied successfully to a variety of industries and processes. Use the following list to spark ideas for application at your site. Some measures are repeated to highlight application in different processes.

Qualified professionals should match the water management measures with specific water-quality parameters and production circumstances.

### Target Areas for Water Savings

- **Cooling & Heating Systems**
  Boilers, hot water, & steam Evaporative cooling systems
  Single-pass cooling water use Equipment cooling

- **Process & Equipment Use**
  All applications
  Rinsing & cleaning
  Plating & metal finishing
  Painting
  Photo & x-ray processing
  Dyeing
  Applying degraded water

- **Sanitary, Kitchen, & Domestic Use**
  (except Medical care facilities)
  Faucets
  Showerheads
  Toilets
  Kitchens

- **Medical Care Facilities**

- **Maintenance Operations**

- **Landscaping Irrigation Guidelines**

## Cooling and Heating Systems

Water is often treated and used for climate control, process cooling, equipment cooling, and steam generation. Some of the associated equipment includes, but is not limited to, cooling towers, boilers, chillers, air scrubbers, refrigeration equipment, and evaporative coolers.

### Boilers, Hot Water, and Steam

- Capture stem condensate for reuse.
- Fix leaks in steam traps.
- Inspect boiler for proper operation.
- Install automatic blowdown controls for boilers.
- Install automatic controls to treat boiler make-up water.
- Inspect, recalibrate, and repair controls to insure effective operation.
- Insulate pipes and vessels to reduce energy loss.
- Use steam and hot water only where and when necessary.

### Evaporative Cooling Systems

- Install submeters for make-up and bleed-off water for equipment such as cooling towers that use large volumes of water.
- Require service vendors to pay for water used in cooling operations.
- Prepare performance specifications for chemical service vendors. Require proposals with projections of water consumption and chemical use.
- Control cooling tower bleed-off based on conductivity by allowing bleed-off within a high and narrow conductivity range. This will achieve high cycles of concentration in the cooling system and reduce water use in cooling towers.
- Maintain cooling system water treatment.
- Inspect drift losses. If excessive, install drift eliminators or repair existing equipment.
- Achieve at least five cycles of concentration or the maximum number of cycles achievable without scale formation. Implement measures to remove or compensate for minerals which may form scale.
- Consider alternative water treatment technologies to achieve high cycles of concentration. Some may be used in combination with each other. The suitability of the treatment will depend on

factors specific to each site, such as make-up water quality, cooling tower materials, operating temperatures, and system monitoring capability. Some alternative treatments that have been successfully demonstrated are:

- Softening of make-up water;
- Side stream filtration (including nano-filtration, a form of low pressure reverse osmosis); and
- Side stream injection of ozone.

Beware of vendors offering "new" treatment chemicals and equipment. Check product track records for satisfactory performance with applications similar to your own. Use good judgement.

- Recover, treat, and reuse filter backwash water.
- Consider side stream softening for very large cooling loads.
- Reuse water from other site uses.
- Convert open evaporative systems to closed-loop cooling systems, such as air cooling, refrigeration, or evaporative condensers (see **Typical Cooling Tower Operation** diagram on page 36).

### Single-Pass Cooling Water Use

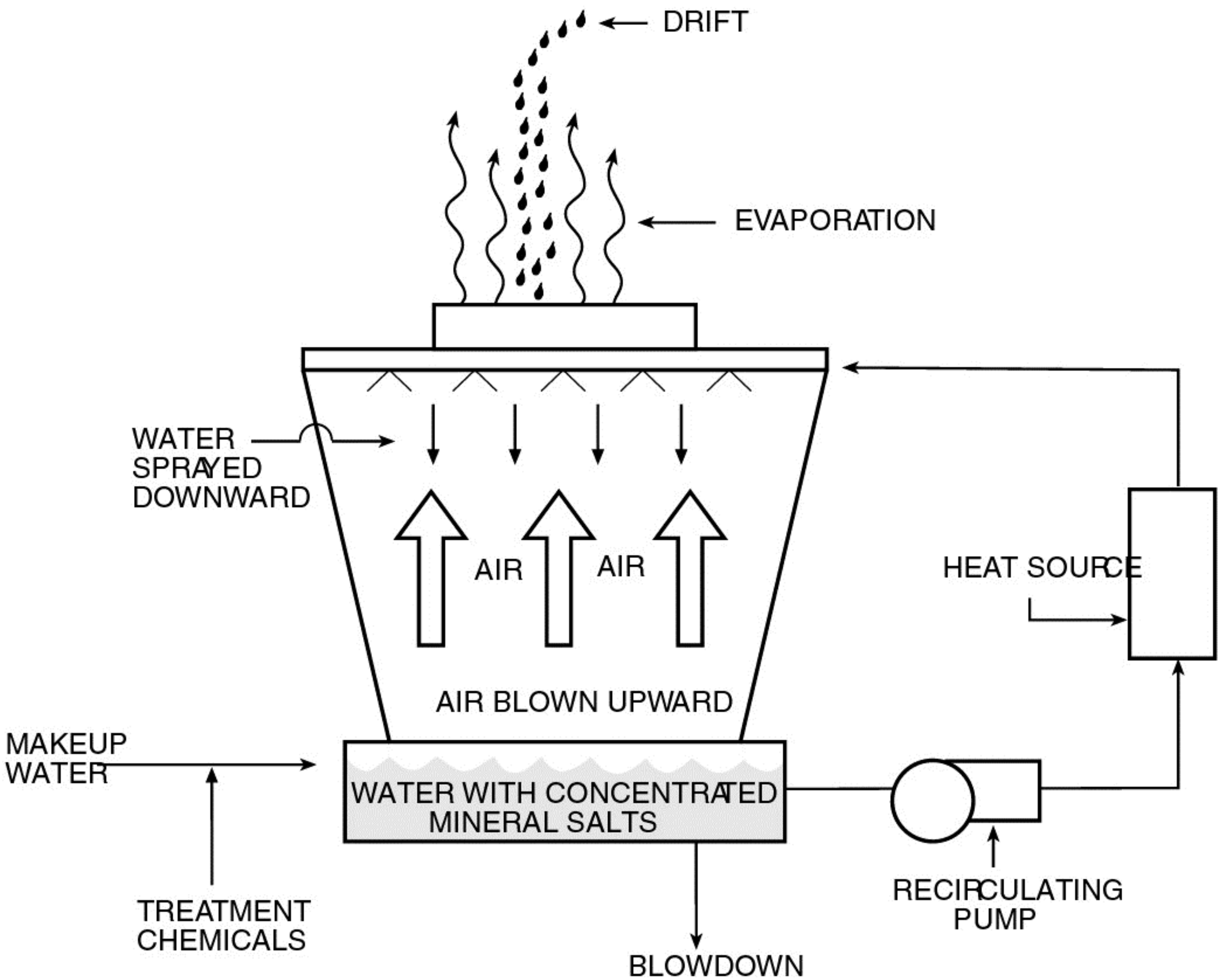
- Eliminate all single-pass water use. Investigate all possibilities for reclaiming and reusing this water, including closed-loop cooling systems.
- Reconnect chillers and condensers after repairs to closed-loop cooling systems.

### Equipment Cooling

**Note:** Match quality of reused water with the quality needs of the application.

- Cool machinery with closed-loop water cooling systems.
- For make-up water in non-contact cooling systems, substitute reclaimed water for potable water.
- Install air coolers to reduce loop water temperature when outdoor conditions permit.
- Modify CAT scanner cooling to use a closed system.
- Use chilled or condenser water to cool remote water-cooled air conditioning units.

## Typical Cooling Tower Operation




<u>SOURCE</u>: ***Case Studies of Industrial Water Conservation in the San Jose Area***

- Cool air compressors with a closed-loop system.

- Reuse non-contact cooling water for boiler make-up water or other purposes if water quality is good enough.

- Reuse contact cooling water for cooling tower make-up water if water quality and temperature is adequate.

- Reduce spray water and recover heat from testing jet and rocket engines by installing heat exchangers.

- Reuse water used to immerse or otherwise rapidly cool hot and molten materials.

- Control make-up water and reduce blowdown by adding temperature control valves to cooling water discharge lines in equipment such as air compressors and refrigeration systems.

- Where available, substitute high-efficiency electric chillers for steam turbine chillers during off-peak electric rate periods.

- Recover compressor and vacuum pump seal water, and apply it to cooling or boiler make-up supply.

- Eliminate cooling boiler blowdown or steam condensate with fresh water. Install an expansion tank if required. If cooling is needed, apply used water such as reverse osmosis reject water.

- Recover steam condensate and recycle to boiler make-up water.

Use reverse osmosis reject water or other used water for single-pass purposes such as for pump cooling.

## Process and Equipment Use

Processing and cooling can consume 98 percent of water used by manufacturers. Because each processing system is unique, general water management procedures should be adapted to suit individual company or institutional needs. The person responsible for implementing the water management plan should perform a detailed audit of each major water use.

### All Applications

- Review all systems to determine if less water can be used in each process and machine. Determine whether present water uses are necessary and if the latest water-saving technology is being used. Go beyond the standard information provided by equipment manufacturers to investigate the real need for water use.

- Install pressure reducers where high-pressure municipal pressure is not needed.

- Reheat the water at the point of use or re-use hot water from other applications instead of adding fresh, hot water for tanks and baths used to heat products.

### Rinsing and Cleaning

- Apply counter-current rinsing and cleaning techniques (see **Three-Stage Counter-Current Rinse** diagram on page 40).

- Use measured amounts of water rather than continuous streams for rinsing and cleaning. Use drag-out reduction technology for rinse baths. Use water only when actually needed to rinse the product.

- Apply water-saving technologies or modifications that are specifically geared toward your facility. Examples are counter-current rinsing, drag-out tanks or first stage static rinses, spray systems, flow reduction devices, motion detectors, light beam switches, solenoid or timer shut-off valves, pH or conductivity controls, and batch processing.

- Do not use water softening, reverse osmosis, or deionized water where it is not critical.

- Check controls, sensors, and valves frequently to assure effectiveness. Adjust or repair equipment as needed.

- Install ultrasonic cleaning equipment for reusable containers and degreasing.

- Select automatic washers that continuously re-circulate wash and rinse water for cleaning reusable containers.

- Replace caustic jet spray rinses with a burn out oven for cleaning used engine parts, then bombard cleaned parts with beads and shot to remove any residue. This also reduces the need for toxic waste disposal.

- Recycle water used in head polishing machinery.

- Recycle "clean-in-place" rinse water for next caustic wash.

- Integrate monitoring of flow parameters in "clean-in-place" systems. This can ensure proper cleaning and reduce longer-than-necessary rinse flows. Parameters may include flow, time, temperature, pressure, and conductivity.

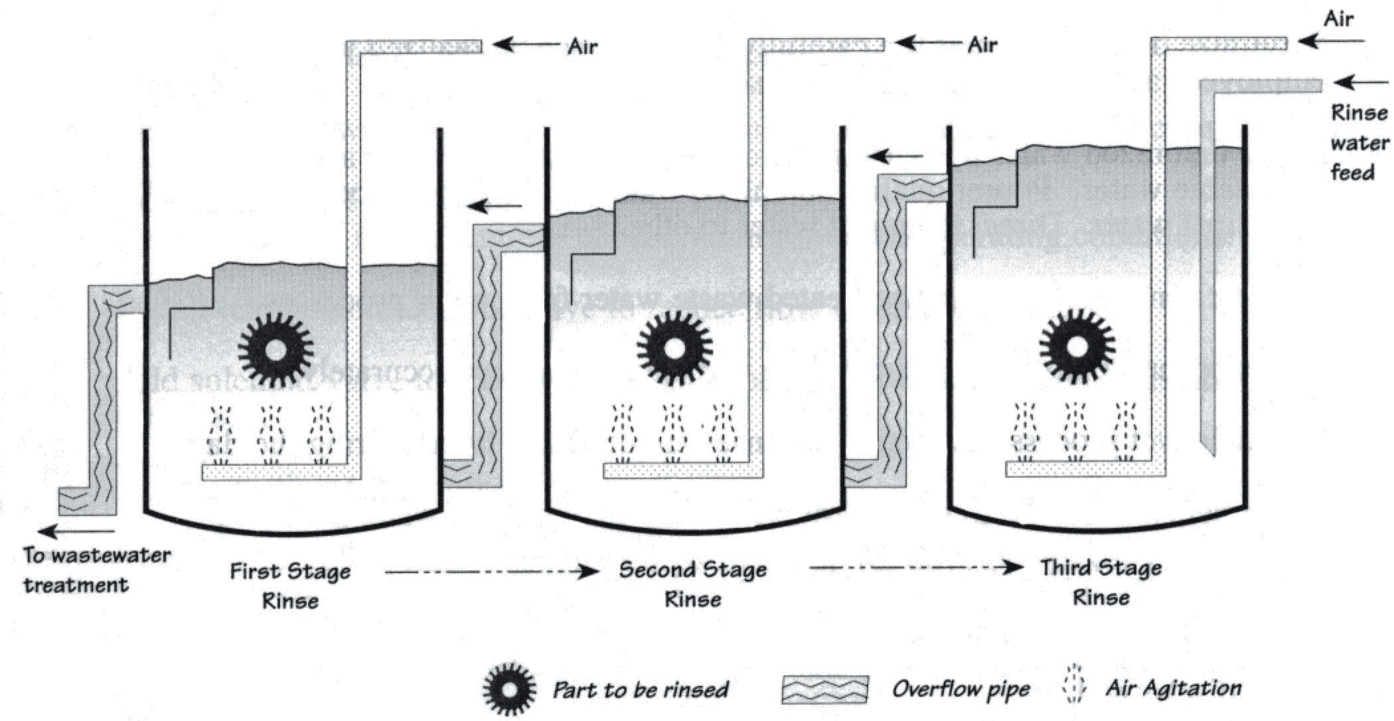
- Use less water for partial loads for laundries.

- Recalculate laundry formulas for less water.

- Recycle rinse water to next wash.

- Reclaim wash water with treatment such as dissolved air flotation and filtration.

## Three-Stage Counter-Current Rinse




<u>SOURCE</u>: ***Environmental Pollution Control Alternatives: Economics of Wastewater Treatment Alternatives for the Electroplating Industry***, "Reducing the Costs of Wastewater Treatment," U.S. EPA 625/5-79-016. 1979. Reproduced with permission.

- Reduce rinse water in solvent degreasing with tamper-proof conductivity meters to control make-up water to rinse tanks.

- Consider batch processing. A batch processing procedure can be implemented for equipment that currently processes items individually. Processing items simultaneously enables more efficient use of process water, saves time, and increases productivity.

- Reduce the amount of reverse osmosis water used by eliminating continuous rinses.

- Scrutinize deionized water use carefully. Savings can be realized just by making employees aware of deionized water use.

- Reuse deionized water by sensing the quality of used rinse water and recycling acceptable water. Poorer quality deionized water may still be of better quality than municipal water. Direct the reject water to other uses.

- Convert some processes to use treated wastewater from other processes.

- Use appropriate nozzles to direct rinse and cleaning sprays accurately.

- Schedule wet process production so rinses are on fewer hours during the day.

- Use timers and conductivity controllers to control quality of water in rinses.

- Turn off municipal water or treated water when processes are not in use.

- Use low-pressure portable pumps for wash stations to reduce the total amount of water discharged.

- Recycle water in test tanks.

- Install automatic controls on conveyor belts to stop wash water and lube water when belt is not running. Do not operate conveyor when process does not need it.

- Recover, treat, and reuse filter backwash water.

### Plating and Metal Finishing

- Treat and reuse rinse water for other compatible cold water rinses.

- Use air knives to reduce dragout and keep subsequent rinse water at a higher quality.

- Allow dragout to drain into plating tank before moving work to rinse tanks.

- Add dragout tank or first-stage static rinse and manually-controlled throttling valves and meters.

- Treat rinse water to recover valuable metals or chemicals to return to plating bath, with clean water returned to rinse system.

- Consider evaporator/condenser systems or membrane systems for separating rinse water from plating solutions, for recycling, or both.

- Convert to counter-flow cascade rinse systems.

### Painting

- Use an electrostatic process to paint metal surfaces.  The electrostatic process reduces air pollution and eliminates the need for water curtains.

- Recycle water used to collect overspray paint by treating water with dissolved air flotation and filter dewatering system to separate toxic solids.

- Replace water wall paint spray booth with a dry filter medium to collect overspray.

### Photo and X-Ray Processing

- Reduce flow to manufacturer's specification for actual operating conditions.

- Install temperature control valve to reduce flow when not developing.

- Add solenoid valve to shut-off rinse and cooling flows when product is not being processed.

- Update equipment to low-water use types.

- Consider recycling rinse bath effluent as make-up for developer/fixer solution.

- Consider evaporator/condenser systems or membrane systems for separating rinse water from plating solutions, for recycling, or both.

### Dyeing

- Reuse water from light-colored applications for batch dyeing operations.

- Consider separating rinse drains and recycling some rinse water as dye bath make-up.

### Applying Degraded Water

- Re-use reverse osmosis reject water for other uses.  Depending on reject water quality, uses may include process cooling, equipment cooling, fume scrubbers, photo processing, washing areas not needing ultra clean water, and irrigation.

- Minimize use of municipal water for scrubbers by properly controlling make-up water and using wastewater from other on-site processes.

## Sanitary, Kitchen, and Domestic Use

The following items DO NOT APPLY TO HEALTH CARE FACILITIES. See the section on Medical Care Facilities beginning on page 44 for suggestions on approved water management ideas.

Among commercial users such as hotels and office buildings, 80 percent of water used is in bathrooms and kitchens. Consider the following ideas:

### Faucets

- Install low-flow aerators or laminar flow restrictors; better yet, replace with spring-loaded types that automatically shut off.

### Showerheads

- Install devices that flow at no more than 2.5 gallons per minute, or less if required by local ordinance.

### Toilets

- Install 1.6 gallon per flush toilets and 1.0 gallon per flush urinals.
- Reduce flows delivered by flush valves. On flushometer-type toilets, have a plumber inspect valves for reversible conserving rings or acceptability for other modifications to reduce flow.
- De-activate automatic water flushing systems in urinals and toilets. Change to a manual mode. If absolutely necessary to use automatic systems, reduce volumes and extend timing cycles.
- Operate all automatic systems only during work hours.

**NOTE**: Since January 1, 1994, federal law has required that all new construction to use toilets with no more that 1.6 gallons per flush, urinals with no more than 1 gallon per flush, and showerheads with no more than 2.5 gallons per minute. Similar laws were already in effect in Texas, Massachusetts, and California. The federal law is included in Appendix C.

- Encourage employees to report leaky toilets and faucets. Promptly fix the leaks.
- Promote water-saving habits.

### Kitchens

- Eliminate garbage disposals and water-cooled ice makers, when possible.
- Reuse non-contact cooling water for water-cooled machinery such as milkshake machines, frozen yogurt machines, and refrigerators.
- Replace water-cooled compressors with air-cooled units.

- Install spray rinses in kitchen sinks with manual control ("dead man shut-off") valve attached; that is, remove spray valve lock ring.

- Consider installing on-demand point-of-use water heating systems to eliminate employees running water while waiting for hot water. An option would be to insulate hot water piping.

- Recycle rinse water to next wash in dish washers.

- Use appropriate nozzles to accurately direct rinse and cleaning sprays.

- Use dishwasher wastewater in garbage disposal.

- Make sure eye-wash stations and water fountains do not run needlessly.

- Remember to audit kitchen, cafeteria, laundry, dish washing, washdown, janitor closets, research, and laboratory areas.

- Use water softener only where needed, such as water heater feed water. Optimize regeneration and rinse cycles for ion-exchange water softeners to minimize calcium-laden reject water or sodium-laden rinse water. Most water softeners add sodium, which affects the desirability for potable water. Control regeneration of the system with a dissolved solids sensor rather than a timer. Check settings so flow rate and duration of flushing cycle are correct. Be aware that water is used to refill the brine tank.

## Medical Care Facilities

Hospitals, nursing homes, convalescent homes, and acute-care facilities must protect the health of the patients. These patients are susceptible to disease, which would not affect a healthy person. For this reason, health care facilities cannot use many of the water-efficiency measures applicable to residential and commercial structures. California health care facilities are strictly regulated by the Department of Health Services Licensing and Certification, the Statewide Office of Health Planning and Development, and the Joint Commission on Hospital Accreditation.

- Repair leaks.

- Install new design 1.6-gallons-per-flush toilets.

- Reroute refrigerator cooling lines away from drains and into condensate return lines.

- Recycle condensate return.

- Increase management and employee awareness of need to use water efficiently.

- Replace water-cooled units for vacuum pumps, air compressors, and refrigerators with air-cooled units.

- Modify x-ray film processors within manufacturer's specifications to use less water.

- Add interlocking control valves to x-ray film processors so water flow is stopped when equipment is not in use.

## Maintenance Operations

Routine maintenance practices will help locate problems quickly, keep equipment operating at peak efficiency, and maximize results of the water and energy management program.

- Maintain cooling towers under a regular treatment and cleaning schedule.

- Document and enforce a routine leak detection program. Include inspection of all valves.

- Inspect steam lines and traps; repair promptly.

- Use wet wash rags and brooms instead of hoses for housekeeping.

- Minimize or eliminate the amount of water used for washdown. Find methods of cleaning that require little or no water.

- Install a high-pressure, low-volume system for clean up.

- Install spring-loaded valves or timers on all manually operated water outlets.

- Repair domestic hot water system to avoid wasting water. Consider installing on-demand point-of-use water heating systems to stop customers and employees running water while waiting for hot water.

- Use low-pressure portable pumps for wash stations.

- Reduce pressure of hot water used for clean up.

- Discontinue using water to clean sidewalks, tennis courts, pool decks, driveways, parking lots, and other hardscapes.

- Use reject water or process wastewater to clean areas requiring grease removal. With hoses, use high pressure, low-flow spray equipment and shut off nozzles. (Check with local health authorities.)

- Cover swimming pools when not in use.

- For freeze protection of water lines, place shut-off valves in freeze-protected sites rather than running water continuously.

## Landscaping Irrigation Guidelines

This list provides water management tips that have been successfully implemented by industrial and commercial users.

- Develop a schematic of all water-entry points. Know the location of faucets, time clocks, solenoids, booster pumps, sprinklers, and bubblers.

- Identify the capacity of each water-carrying unit and frequency of use.

- Determine specific use for each entry source.

- Require landscape managers to be trained and certified as irrigation auditors. For information on schedules of classes, contact the DWR staff listed on the inside rear cover or the California State Polytechnic University at San Luis Obispo at (805) 756-2434.

- Ask the water utility to provide irrigation audit assistance.

- Hire a landscape architect with water conservation and Xeriscape experience.

- Use turf only where actually necessary, for example within and immediately around lunch areas and sports fields.

- Eliminate small, uneven areas of turf, since they will be difficult to irrigate without wasting water.

- Use appropriate plant material in nonturf areas.

- Use automatic irrigation systems.

- Install watering systems designed with separate valves for turf and for other types of plants, trees, and shrubs.

- Operate sprinkler system before sunrise and after sunset. The amount of water applied should be scheduled according to evapotranspiration rate, plant water needs, slope, and soil type of the site. Ask a landscape irrigation auditor for assistance.

**NOTE:** Landscape auditors are certified by the Irrigation Association. Therefore, if your water utility cannot help you, contact the Irrigation Association at 8260 Willow Oaks Corporate Drive, Suite 120, Fairfax, Virginia, 22031; phone (703) 573-3551, Fax (703) 573-1913, or internet: www.irrigation.org.

- Stop irrigation water from running onto streets.

- Use reclaimed water for irrigation wherever possible.

- Use the California Irrigation Management Information System to obtain weather data to help schedule frequency and duration of irrigation. For further information contact the DWR staff listed on the rear cover.

## Chapter 4: Case Studies in Efficient Water Management by Businesses

Retail businesses, manufacturers, and institutions in many parts of North America have implemented successful, cost-effective water management projects. This chapter describes practical examples of successful water management programs often conducted with energy and wastewater discharge reduction programs. To assist readers in implementing their own efficiency improvements, each example provides references for additional information.

### Automotive Paint Manufacturer Reduces Contaminated Wastewater

Disposing of contaminated waste with little impact on the environment is one of the biggest challenges facing industry today. In particular, this applies to the automotive coatings manufacturing industry which produces large quantities of contaminated wastewater from the manufacturing process. One such manufacturer, PPG Industries, Inc., has developed a way to reduce the amount of contaminated wastewater produced. By implementing a new energy-saving technology at its Cleveland, Ohio manufacturing plant, the company reduced its effluent from 400,000 gallons of contaminated water each year to 20,000 gallons per year.

***Challenge***— Automotive coatings and paints include both solvent-based and water-based products. To ensure the quality of water-based coating products, the manufacturing equipment must be cleaned regularly. This requires using thousands of gallons of water each week. If the contaminates are not removed from this water, it must be disposed of as a hazardous waste.

***Solution***—In 1991, a team of PPG engineers investigated ways to minimize this waste. With assistance from a U.S. Department of Energy and U.S. Environmental Protection Agency grant, the team designed and installed a combined ultrafiltration/reverse osmosis (UF/RO) process to clean up the wastewater. Combining these two membrane-based technologies to form a progressive filtering system cleaned the wastewater effectively enough for reuse in equipment cleaning operations.

***UF/RO System***—The UF/RO process is capable of recovering 95 percent of the wastewater. First, the water is prefiltered to remove large solids. Then it is moved to the ultrafiltration unit where suspended solids and high-molecular-weight particles are removed. The smallest impurities are removed in the reverse osmosis unit.

Although the final water still contains ketones and other impurities in low concentrations, it is suitable for cleaning. It is then pumped into a storage tank for reuse. The remaining 5 percent generated by the UF/RO system is highly concentrated wastewater that can be easily handled under the plant's current waste management procedures.

***Energy Savings***—PPG has experienced significant energy savings by reducing contaminated wastewater. Reduced fuel for transporting waste and for incineration, and less deionized water treatment yield energy savings of 3.6 billion Btu per year.

***Economic Savings***—The total cost of PPG's UF/RO system installation was $454,000. The annual net savings from the system are $205,000—equal to $380,000 of water disposal costs savings less $175,000 for unit operating costs.

***Environmental Benefits***—The environmental benefits of PPG's UF/RO system are substantial. Not only has the volume of hazardous waste been reduced from 400,000 gallons to 20,000 per year, but atmospheric emissions from waste incineration are also lower by several million kilograms per year.

Emissions are also lower because of the reduced transportation of waste. In the past, tanker trucks traveled 350 miles to the waste energy recovery facility 65 times each year. Now, only four trips are necessary—reducing annual emissions by several hundred thousand kilograms.

***Applications***—PPG and the State of Ohio are working to increase industry awareness of this energy-saving technology through various types of publicity. If the technology is adopted by other automotive coatings manufacturers, the annual national energy savings could equal 66.3 million Btu.

The UF/RO system was installed at the PPG Cleveland plant in April 1992. Construction and installation of the new equipment did not require changes in the plant's production processes and did not affect the manufacturing rate.

**SOURCES:**

"Reducing Contaminated Wastewater from Water-Based Paint," by Niki Malenfant, National Renewable Energy Laboratory, U.S. Department of Energy, October 1993.

Ruth Gonsen, Ohio Department of Development, P.O. Box 1001, Columbus, Ohio, 43266-0101

Maura C. Tinter, Environmental Coordinator, PPG Industries, Inc., 3800 West 143 Street, Cleveland, Ohio 44111

## Avoid Cost with New Manufacturing Techniques

Water efficiency, waste reduction, and other forms of conservation have been slow in coming. Government restrictions have forced many companies to take serious action in conservation. As a result, companies found that using new technologies to meet the government demands have resulted in an added bonus—reductions in production costs. After implementing new manufacturing techniques to avoid installing expensive conservation and pollution control equipment, companies experienced lower production costs and higher returns.

Motivation for companies to reduce pollution and waste control could also be applied to water efficiency. The high demand for water use and limited water supply have resulted in increased rates. Implementing simple water-saving methods could reduce production costs immediately.

Some companies have already experienced some noticeable savings:

- Clairol Co. decreased water use by insertng foam balls into pipes to clean the pipes. They saved $240,000 by reducing wastewater 70 percent.

- Carrier Corp. eliminated toxic lubricants from its manufacture of air conditioners. They spent $500,000; they saved $1.2 million.

- AT&T stopped using an ozone-depleting compound in its circuit-board manufacture. They saved $3 million in annual costs.

- Whyco Chromium Co. replaced harmful byproducts from the process of coating nuts and screws with a new alloy. They saved 25 percent in production costs.

- 3M Corp. developed an adhesive for box-sealing tapes and eliminated the need for $2 million in changes to control pollution. They saved $41 million in three years.

- Polaroid Co. eliminated mercury from their batteries so they could be recycled and streamlined photographic chemical plants. They saved $250,000 by reducing waste by 31 percent.

George Wenger, of AT&T's materials and process group, said environmental standards were tightening so rapidly that AT&T is not going to wait to see how hard it will be to adopt new technologies, because these technologies will put the company in a competitive position in the long run.

The 3M company estimated that its 2,500 different manufacturing changes since 1975 have saved $500 million and cut their toxic emissions in half.

Mark Hyner, President of the Thomaston, Connecticut company that developed the new coating for Whyco, said small companies can't afford to do this research under pressure of compliance deadlines. “Most of our time and resources are spent dealing with regulations.” He would like EPA to say “Let's see how we can do things differently,” or for the government to offer tax incentives for innovative technologies.

David Berg, EPA Director of Technology Innovation and Economics, said “the current environmental legislation creates disincentives” for companies to undertake pollution-prevention technologies.

A fundamental consideration that keeps many companies from adopting “clean” manufacturing technologies is the customer's long-established “specifications.” Even though the new technologies won’t affect product quality, suppliers are afraid their customers won’t buy.

**SOURCE:**
“Many Companies Cut Pollution By Altering Production Methods,” Amal Kumar Naj, ***Wall Street Journal***, December 24, 1990.

## Boiler Water Blowdown Recovery

A major food processing company with sites throughout the United States has 22 boilers which operate at pressures of 250 to 600 pounds per square inch and generate approximately 6.5 million pounds of steam per hour. Their makeup water is provided by either municipal water (purchased) or clarified river water (provided by company's own pumped well or river supply) depending on the site locations, and all then use sodium zeolite softening. Steam generation systems are all designed very well including process heat recovery, blowdown flash tanks, and blowdown heat exchangers. Because of the excellent heat recovery, the company immediately concluded that water conservation, not energy conservation, was the major factor to consider when justifying its projects.

An operator, a shift foreman, the utility manager, the plant engineer, and a Cyrus Rice Consultant Group (CRCG) representative formed a team at each site. They first defined the major areas of water usage and discharge. The CRCG engineer and one of the team members then performed a more in-depth audit of each system(s). This process usually took three to five days, though not necessarily consecutively. The gathered information on water flow rates, temperatures, qualities, theoretical volumes required versus actual, and flow reduction available through operating modifications and localized water reuse. The summarized findings and related comments were in a preliminary report for each team member to review and then either support, refute, or add comments relative to the work. This summary also included assumed costs for power, water, fuel, regenerants, chemical additives, and related items, so purchasing or other site personnel could update them if required.

After reviewing the report, the teams again met and agreed that eliminating excessive blowdown would lead to the highest measurable water reduction and should be the first project undertaken. The corporate staff confirmed similar savings should be equally available for all their sites. The original site was selected to confirm whether these theoretical savings could actually be achieved, because the site was the most involved and its manufacturing levels and utility costs were about mid range to the others,

Due to the low energy losses, boiler blowdown rates were maintained at a conservative 15 to 20 percent of makeup to be sure carryover would not cause problems or damage to the super heaters, turbines, or downstream processes. Since most boilers of their size and design can be operated at blowdown levels of at least 12 percent, a steam purity study was performed on each of their five boilers to confirm the conditions for carryover.

Each boiler was tested over a three-day period under varying steam loads, drum levels, boiler water solids levels, and firing conditions, including various combinations of these conditions, to determine maximum and minimum safe operating conditions. Interestingly, although the boilers were identical in design and operation, their safe operating conditions were quite different, requiring different control levels for each. Testing revealed that one of the boilers had a mechanical problem, since whenever the steam load was increased or the drum level dropped below a certain level, carryover was noted. A later inspection confirmed the feedwater line had rotated and was spraying directly up into the steam separators at high feedwater rates or during low drum levels. Site personnel later stated this finding alone paid for the entire evaluation at all sites.

The data developed from the test demonstrated that original estimates were very conservative. Actual savings would be about 25 percent above original estimates. The next step included developing specifications for automatic blowdown controls and proportional chemical injection equipment to help assure the new limits would be maintained. The equipment was then purchased.

This project, which had been discussed for five years but never implemented, took less than 12 months to complete from the first meeting until the equipment was installed and savings confirmed. The first site demonstration indicated a reduction in water consumption and sewer water discharge by over 31 million gallons per year, well above the original goal set. When salt, boiler and condensate treatment products, and energy savings are also added in, the cost savings achieved are $186,000 annually for a one-time cost of less then $45,000 including consultant fees, engineering, equipment rental for steam purity analysis, and purchase of the automated blowdown and chemical feed systems.

The company is now completing the same studies and system designs at each of its other sites now that the project approach has been defined and savings potential determined.

**SOURCE:**
"Water Conservation and Reuse Programs Can be Self-Supporting" by Albert Owens of Cyrus Rice Consulting Group of Pittsburgh, Pennsylvania. This paper was presented at WATERTECH '92, November 11-13, 1992 in Houston, Texas. These portions are reprinted with permission of Tall Oaks Publishing Inc. of Littleton, Colorado, the conference organizer.

## California Linen Rental Recycles

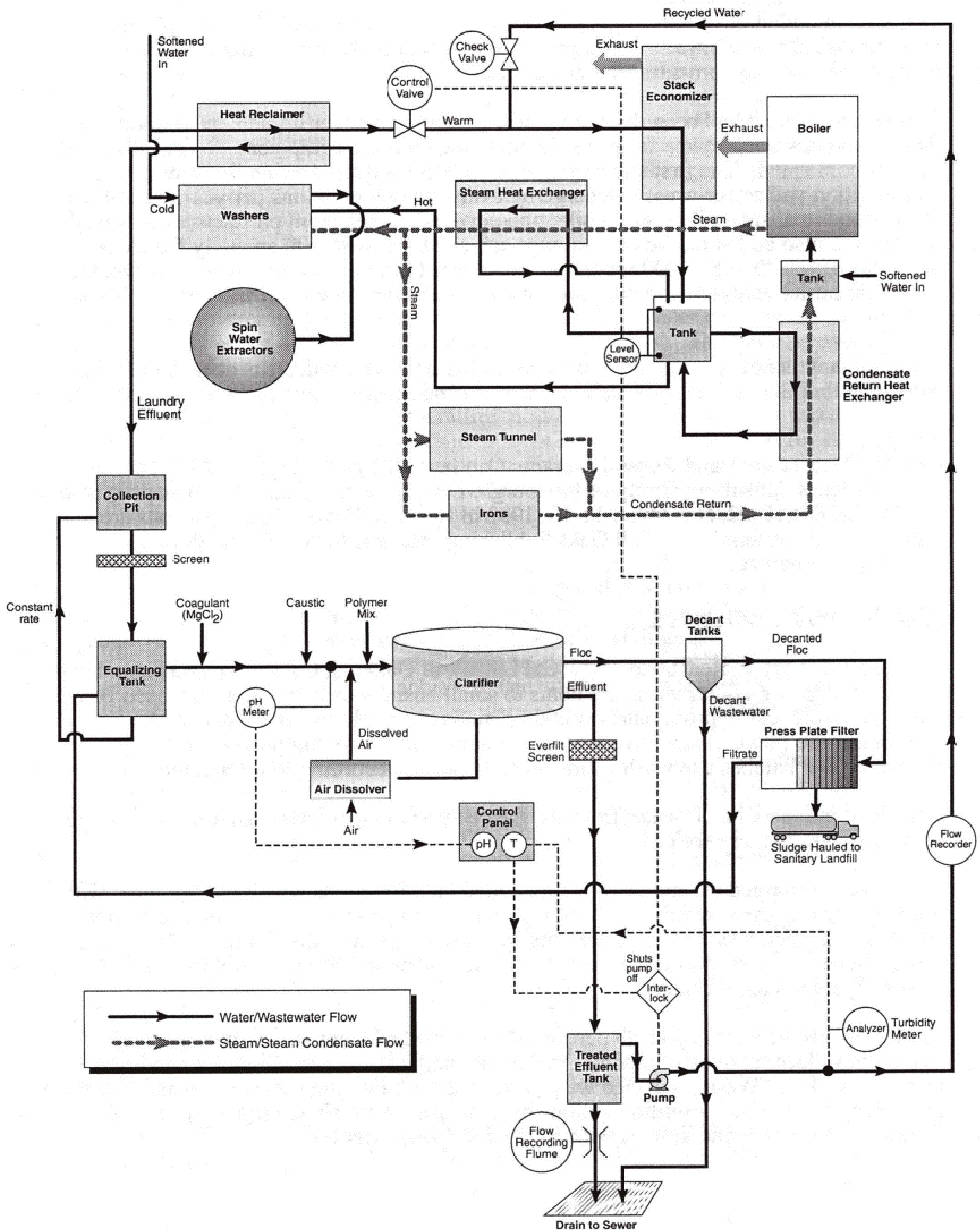
The California Linen Rental Co., Inc. (Cal Linen), of Oakland, California, rents laundered linens, clothing and other washable items to small businesses in the San Francisco Bay area. They process approximately 50,000 pounds per work day and employ 112 workers in the plant. They have nine automated 400-pound computer-controlled washers. The batches use wash formulas and operate according to a schedule.

Cal Linen purchases their water from the East Bay Municipal Utility District which also provides wastewater services.

Cal Linen discharged oil and grease from soiled laundry goods which did not meet with wastewater discharge regulations. In order to comply with these standards, the linen company installed a system to pretreat its wastewater prior to discharge. In 1992, Cal Linen successfully modified the wastewater treatment and began operating the system that recycled treated effluent.

Cal Linen now recycles up to 50 percent of its treated effluent stream by injecting caustic to reduce hardness, reducing particulate matter, and controlling automatically a pumping system. Warm, recycled water is routed back into the hot water system, saving heat energy and up to 11 million gallons of water per year (see diagram, on page 53 **Laundry Pretreatment system with Recycling Components**).

## Laundry Pretreatment System with Recycling Components



At the 50-percent effluent recycling level, the annual benefits from the recycling pretreatment system are projected at $28,345, compared to the annual costs without recycling of $16,248. With a capital outlay to make recycling possible of $37,137 at 1992 prices, this represents a payback of just under one and a third years. With the cost of water and wastewater services rising faster than most other goods and services, this financial picture is likely to become even more favorable for Cal Linen. With the growing trend for water utilities to introduce use restrictions and higher inclining rate structures, water intensive industries such as commercial laundries will find effluent recycling systems increasingly cost effective.

This case study illustrates how the annual savings from recycling significantly contribute to the repayment of unavoidable pretreatment system capital costs. However, when viewed as a whole, the current and projected future savings of Cal Linen's pretreatment and recycling system could not be considered cost effective purely on the basis of the overall avoided costs. If it had not been a mandatory requirement of wastewater compliance, the combined system would most likely have been rejected due to the approximately 18-year payback it requires.

**SOURCE:**
***A Case Study of the Recycling of Pretreated Process Effluent Water at a Commercial Laundry Facility in Northern California***, prepared by East Bay Municipal Utility District for DWR, June 1992.

## Circle K Stores—Symptoms for Retail Chains

The city of Mesa, Arizona, sponsored water audits at fourteen Circle K stores for 12 months. The water audits demonstrated cost-effective ways to save water for a small commercial water user with multiple facilities.

The water use varied not just from store to store but within the same store from month to month. The city discovered five stores had water leaks which lost a total of approximately one million gallons in 12 months. Circle K possibly lost more with leaks that were undetected.

The audit's recommendations to avoid further major water losses and to maintain water efficiency were:

***Store managers***—Because water bills were sent to the main office, store managers were not aware of the water consumption at their store.

Corporate offices need to provide water use data to store managers and stress the importance of prompt leak repair.

***Repairs***—When repairing water-use equipment, replace with water-efficient equipment.

***Landscape design***—All four of the stores that had landscaping used a timer on their drip irrigation system. All maintenance work was contracted out. The recommendation was:

- Install only low-water-use design for future stores with landscaping.

**SOURCE:**
***Water Audit—Circle K,*** City of Mesa, Arizona, and the Circle K Corporation, September 1988.

## Computer Models Identify Savings for Dairy Plant

The Maplehurst dairy plant in Indianapolis, Indiana is a medium-sized plant, which produces fluid milk, orange juice, cottage cheese, and ice cream. Maplehurst participated with Purdue University and the U. S. Environmental Protection Agency in a series of efforts to identify measures to reduce water and energy consumption while still considering environmental and economic factors.

The initial efforts measured water consumption, wastewater discharge, and energy use at the dairy. Then efficiency measures were recommended and in many cases implemented. The more recent efforts produced the WEEP, FOODS, and BATCHES computer models, which simulate food processing operations and quantify the effectiveness of potential efficiency measures.

### Dairy Efficiency Measures

Allocation of the Maplehurst's utility requirements to products yielded the following values per 1,000 pounds of finished products.

**Process Utility Requirements per 1,000 Pounds of Finished Products**

| Product | Steam (lb) | Electricity (kwh) | Water (gal) |
|---|---|---|---|
| Fluid Milk | 195 | 23 | 226 |
| Cottage Cheese | 1,153 | 91 | 3,420 |
| Ice Cream | 650 | 584 | 979 |

The observations indicated opportunities to increase the process efficiency by designing better water and energy reuse and recovery techniques. These were:

***Steam Use*** —The plant used steam in the heating system, hot water system, cheese vats, and sanitation process. The recommendations were**:**

- Insulate all of the steam lines. Also insulate the building.
- Change to a hot water boiler system to eliminate the flash and blow-down losses. (The plant used an injected steam system which recirculated through the heating section.)

***Waste methods***—All of the waste streams are originally mixed together before being disposed. Several different designs could correct this, but the technical and economic alternatives need to be evaluated. The potential recommendations were:

- Segregate the waste streams to recycle the high-quality wastewater obtained from the lactose purifying method.

- Capture all the sludge discharge, product waste, and rinse water from the equipment (with the exception of any water that has detergent wash). Direct this stream to a separate tank. With the reverse osmosis system, the streams recover the milk solids and capture and recycle the clean water.

- Reduce biological oxygen demand content by treating the detergent wash stream, floor cleaning, etc., with an anaerobic treatment before discharging into the sewer. Then use the by-product for ground fertilizer or incinerated for energy production.

- Install self shut-off nozzles on all of the clean up hoses to reduce the energy usage by 25 percent as well as reduce the water being discharged to waste.

## Computer Models

Waste, Water, and Energy Estimating Program (WEEP) was recently developed by the Agricultural Engineering Department at Purdue University to estimate the distribution of waste, energy, and water over the different operations in a multi-product dairy plant. WEEP takes the plant's monthly production, utility bills, and municipal bills as the input data. It can then identify specific areas where water efficiency and energy usage could be improved or waste reduced. WEEP is presently being converted to a spreadsheet program for PC's. Modification is easy for particular situations, and it will automatically update the results. The spreadsheet allows more menu options to present output. By providing the distribution of energy, water, and waste for the plant manager through WEEP, the plant manager can get an idea how the plant's efficiency compares to similar plants.

Food Operations Oriented Design System (FOODS) is a program, which can be used for various liquid food materials to determine preliminary process designs and economic analysis of those designs. FOODS was originally developed in FORTRAN, and is being converted for use on personal computers.

The user chooses a series of unit operations needed to produce the desired product. The program sizes the unit operations and calculates capital and operating costs with consideration for costs of energy, water, and waste efficiency. The process is optimized to minimize total costs. FOODS can be used to test preliminary designs quickly and easily.

BATCHES is a computer simulation of a plant's minute-to-minute operation to try and expose scheduling problems which FOODS does not consider. BATCHES identified various equipment, calculations, and flow rates for all the streams.

**SOURCE:**
***Environmental Protection Agency Study On A Dairy and Development of Environmentally and Economically Sustainable Food Processing Systems with Emphasis on Extreme Water and Energy Conservation: Water Compliance Branch, Progress Report***; May 1, 1992, October 1, 1992, February 1, 1993, and June 18, 1993; EPA #T955188-01-0; Martin R. Okos, Ph.D., Principle

Investigator and L.F. Huggins, Department Head, Agricultural Engineering Department, Purdue University.

## Concrete Mixing with Low-Cost Water Supplies

The concrete industry is a major user of water. The primary uses are washing aggregate, mixing concrete, and controlling the rate that concrete cures. Since water is a significant part of the industry's product, the availability and cost of water is of primary importance.

The concrete industry may use non-potable water. These supplies usually cost less than potable water and are available in some communities as treated municipal wastewater.

The chemical quality of treated municipal wastewater is generally acceptable for concrete. To confirm that the quality is acceptable, the concentrations of the salts contained in the water must be known. The information is available from the local waste-water treatment facility which maintains accurate records of its product.

Standards exist to guide the concrete producer to assure acceptable strength and color of concrete. Since the standards vary depending on the types of impurities present, use the guidelines only as a quick reference before determining if a specific water sample is acceptable. The best method is to perform a mortar strength test first.

Here are a few examples of some of the specifications:

- The California Department of Transportation's Caltrans Standard Specifications of 1988 (Section 90, Part 2.03) states that all water used in mixing and curing of concrete should be free from oil. There are additional requirements for water used in reinforced and non-reinforced concrete. For example, non-reinforced concrete should not contain more than 2,000 parts per million (ppm) of chlorides as Cl and 1,500 ppm sulfates as $SO_4$. Also, reinforced concrete should not contain more than 1,000 ppm of chlorides as Cl and 1,300 ppm of sulfates as $SO_4$. If concrete is to be prestressed, then concentrations of impurities will be limited to 650 ppm of chlorides as Cl and 1,300 of sulfates as $SO_4$.

- The ***Indian Concrete Journal*** told of the tolerable concentrations of impurities:

1. Sodium and potassium carbonates and bicarbonates ........................................1,000 ppm
2. Sodium Chloride ........................................................................................20,000 ppm
3. Sodium sulfate..........................................................................................10,000 ppm
4. Calcium and magnesium bicarbonates...........................................................400 ppm
5. Calcium chlorides...................................................2% by weight of cement in plain concrete
6. Iron Salts ....................................................................................................40,000 ppm
7. Sodium Iodate, phosphate arsenate and borate ..................................................500 ppm
8. Sodium sulfide.even ........................................................................ 100 ppm warrants testing
9. Hydrochloric and sulfuric acids ..................................................................10,000 ppm
10. Sodium Hydroxide ..................................................0.5% by weight cement if set not affected
11. Salt and Suspended particles..........................................................................2,000 ppm

- The American Society for Testing and Materials (ASTM) has standards regarding ready-mix concrete, Designation C 94-98. It states that if there are no "service records or information" of concrete made with the water in question and the water is not clear or apparently clean, it should undergo an initial batch testing. The batch tests indicate which water samples are safe for use in mixing and curing. The minimum compressive strength requirements used by the ASTM for the ready-mix batch tests are 90 percent.

- The ***Danish Concrete Manual*** made definite statements on organic waste in the water for production of concrete by saying, "humic acids and other organic acids should be avoided" due to the destabilizing nature (McCoy 517).

- The book ***Influences on Concrete*** by A. Klienlogel also supports this point by saying that "humus, peat fiber, coal particles, sulfur, or industrial wastes containing fat or acid" should not be used in mixing water.

Concrete producers who consider other sources of water that will meet the standards of concrete production could cut the cost of concrete production considerably.

**SOURCES:**

California Department of Transportation, ***Caltrans Standard Specifications***, Section 90, Part 2.03, 1988 edition.

Klienlogel A., ***Influences on Concrete***, Frederick Ungar Publishing Co., New York City, New York, Page 158, 1950.

McCoy, W.J., "Mixing and Curing Water for Concrete," ***Significance of Tests and Properties of Concrete and Concrete-Making Materials***, American Society for Testing and Materials. 1966.

Plum N.H. et al, ***Danish Concrete Manual, Bulletin No. 39***, Copenhagen, Denmark, 1944.

(author unknown), “Requirements of Mixing Water for Concrete,” ***Indian Concrete Journal**,* March 1963, Pages. 95, 98, 113.

## Doubletree Hotel Continues to Improve Water Efficiency

In 1991, the city of Ventura, California provided a consultant to help major business customers reduce their operating costs. The consultant provided on-site surveys to identify efficiency measures. The focus was to improve water use efficiency, improve energy efficiency, and reduce wastewater discharge.

The Doubletree Hotel is a full service hotel and includes 285 guest rooms, full banquet facilities, a pool and jacuzzi area, restaurant, and an in-house laundry facility. The hotel operates 365 days per year.

All water used at the hotel was purchased from the city at the rate $1.278 per hundred cubic feet, or $1.71 per thousand gallons. The wastewater rates were $1.71 per hundred cubic feet, or $2.29 per thousand gallons.

Average water consumption was approximately 39,000 gallons per day. If all of the new efficiency measures recommended in the survey were implemented, the reduction in annual water consumption would be more than 2.5 million gallons, worth over $10,000 per year.

The major water uses and measures to achieve these savings are described below. In some instances, a choice of savings measures is offered.

Domestic Uses - Approximately 13,100 gpd (34 percent of the hotel's daily consumption) was used for domestic purposes: toilet flushing, sink use, and showers used by the guests. The recommendations for water efficiency were:

- Install aerators on faucets. Potential savings would be a 45-percent reduction in water volume used, more than 1,000 gpd, worth $1,500 per year. The capitol cost would be $3,000. The payback period would be 2.0 years.

- Install 1.6 gallons-per-flush toilets. Potential savings would be 50 percent of water usage, over 3,000 gpd, worth $4,500 per year. The capital cost would be approximately $42,750. The payback period would be 9.5 years.

- Install water-filled plastic containers as displacement devices in the toilets. This could be an alternative approach to 1.6 gallons-per-flush toilets. Potential savings would be over 351,000 gallons annually, worth $1,400. Capitol cost would be less than $1,500. The payback period would be 1 year.

***Laundry***—A 300-pound washer extractor and a 65-pound washer extractor processed approximately 3,000 pounds of laundry per day. The recommendations for water efficiency were:

- Install a wastewater reclamation system. Sixty percent of the water would be saved and reused, which would be almost 7,000 gpd. This would be a total savings, including energy and chemical savings, of over $11,450. The capitol cost would be $80,000. The payback period would be 7.0 years.

- Install a rinse water recycle system. Twenty-five percent of the water used, which would be 2,700 gpd, would be reused. This would provide a savings of $3,940 per year in water and wastewater costs. The capital costs would be $12,000 and the payback period would be 3.0 years.

**SOURCE:**
***Water/Energy Conservation Study—Doubletree Hotel***, Black & Veatch for the City of Ventura, California, May 1992.

## Gangi Brothers Packing Company

Gangi Brothers Packing Company, San Jose, California, is a major water user that processes and cans tomatoes. The company uses water for fluming tomatoes from trucks, tomato rinsing, vacuum-pump seals, boiler makeup, and cooling. Since the canning industry typically uses large quantities of water, some recycling and reuse of water has been implemented in the past. The motivation for Gangi Brothers was a general concern for efficiency.

In order to increase water efficiency at Gangi Brothers, the following five techniques were implemented:

1. Recycling water within one process.
2. Reusing water in another process.
3. Installing cooling-tower loops.
4. Modifying processes to use less water.
5. Monitoring operations to control water use.

Flume water at the plant is recycled, thus conserving large quantities relative to the previous one-use fluming approach. Water from one flume is recycled to the bin and back to the flume again. Recycling fluming water is a readily transferrable conservation measure, adaptable to other canneries and food processing facilities that use water to transport material.

The amount of fluming water used was reduced by modifying the bin discharge valves. By using intermittent discharges of short duration, but high volume, less water is needed to remove the tomatoes from the bins.

For additional water conservation, Gangi Brothers operates three evaporative cooling towers in lieu of once-through cooling. This constitutes significant water savings.

The company has also implemented a strong employee training and monitoring program. Employees are made aware that water conservation is a company policy. Supervisors watch for waste, such as running hoses left unattended.

The total water reduction at Gangi Brothers in 1989 was 94 million gallons a year or 63 percent of the company's 1983 water use. The company's estimated annual dollar savings is $130,000. Gangi Brothers significantly decreased the ratio of water used, per ton of tomatoes processed, from 1,200 gallons per processed ton to 300 gallons per processed ton. The payback period on the equipment and modifications was less than one year.

**SOURCE:**
***Case Studies of Industrial Water Conservation in the San Jose Area***, City of San Jose, Brown and Caldwell Consultants and DWR, February 1990.

## Gillette Shaves Water Use

The Gillette Company produces blades and razors, toiletries and cosmetics, stationery products, Braun electric shavers and small appliances, and Oral-B care products. The company operates 51 facilities in 26 countries.

In 1972 they started their energy and water conservation programs; as a result, Gillette reduced energy consumption worldwide by 35 percent and water consumption from 30 to 94 percent. For example, the South Boston Manufacturing Center produces razor blades with 94 percent less water; the Santa Monica Manufacturing Center produces the Paper Mate pens with 90 percent less water.

Gillette continues to reduce pollution, improve recycling methods and reduce packaging materials. They reduced chlorofluoro carbons (CFCs) in their aerosol formula but still use the chemical CFC-113, which is used to coat finished blade edges. Gillette worked with the DuPont Company and found an environmentally safe replacement for CFC-113 that still maintains their quality standards. The plants in the United States use the replacement totally. International plants are phasing it in over the next two years.

Another chemical Gillette is trying to eliminate is trichloroethylene for cleaning metal parts before coating. The coating is vital to Gillette's quality. The company’s South Boston Manufacturing Center, after nine years of research, replaced the washing with an aqueous wash process. The aqueous wash process is an environmentally safe metal cleaner for super-clean surfaces needed in the metal finishing industry.

**SOURCE:**
***A Status Report on the Environment***, Gillette Company, Boston, Massachusetts, 1991.

## Medical Center Improves Water Use Efficiency

In 1991, the city of Ventura provided a consultant to help major businesses reduce their operating costs. The consultant surveyed sites to identify measures that would focus on water use efficiency, energy efficiency, and wastewater discharge.

The Ventura County Medical Center is a full service general hospital with 222 beds, operating room, physical therapy, radiology, laboratory, morgue, and in-patient and out-patient care. In addition to the hospital facilities, the Medical Center has on-site food service, a central heating plant, and a laundry facility that serves various county facilities in the area.

All water used at the medical center was purchased from the city at the rate of $1.278 per hundred cubic feet, or $1.71 per thousand gallons. Wastewater charges were $1.472 per hundred cubic feet, or $1.96 per thousand gallons.

Average water consumption was about 76,900 gallons per day. If all of the recommended efficiency measures were implemented, overall water consumption would be reduced 11 percent, worth $10,617. Energy savings would be an additional $11,150. Total savings would be $21,767 per year.

The major water uses and water-saving measures used are described below.

***Domestic Water Use***—Approximately 41 percent of the water used in the medical center was for domestic purposes. This included toilet flushing, sink use, and shower use by patients. The recommendation for water efficiency was:

- Install flow-reduction devices on flush valves. Potential savings in water and wastewater would be 5,000 gallons per day, worth $6,600 per year. The capitol costs would be $785. The payback period would be 0.12 years.

***Laundry***—Two 400-pound washer extractors processed as much as 6,180 pounds of laundry per day. The recommendations for water efficiency were:

- Install a rinse water recycling system to reuse the second and third rinse cycles. Potential water and wastewater savings would be 1 million gallons per year, worth $3,985. Energy savings would be $2,400 per year. The savings total would be $6,385 per year. Total capital costs would be $30,000. The payback period would be 4.7 years.

- Install a valve in the steam supply line to the laundry to shut off the steam when the laundry is idle. Capitol costs would be $200.

***Steam and Water Leaks***—Steam leaks in the cafeteria, laundry, and physical plant accounted for 77 pounds per hour of actual energy consumption. Water leaks were found in faucets, valves, and pipe fittings. Energy savings would be 7,595 therms, worth $1,880 per year.

***Repair Condensate Receiver Pump Set***—Condensate from about 280 pounds per hour of steam was routed directly to the drain instead of being returned to the boiler for reuse. The energy loss was worth $1,316 per month. Repair costs would be approximately $1,500. The payback period would be 1.25 months.

The Ventura County Medical Center is planning to remodel major portions of its aging structures. The medical center has included many of the recommendations in the remodeling plans. This fortuitous timing further reduced the cost of implementing many of the efficiency measures.

**Source:**
***Water/Energy Conservation Study —Ventura County Medical Center***, Black & Veatch for the City of Ventura, California, May 1992.

## Newsprint Made with Recycled Water

The Smurfit Paper Company in Pomona, California is a model of the industrial use of reclaimed municipal wastewater. All of the processes at Smurfit use 100 percent reclaimed water which add up to 3.6 million gallons per day.

Smurfit produces newsprint from recycled paper. Waste paper from various recycling centers is transported to the Smurfit facility. The used paper is separated from large contaminants, mixed with 18,000 gallons of reclaimed water, then de-inked and turned into pulp.

The advantages of using reclaimed water are many. It is two and one-half times less expensive than potable water. The purity of the recycled water equals that of domestic water for process purposes. In times of water shortages, using recycled water eases the demand for potable water. Also, recycled water can be used more than once.

Smurfit recycles 25,000 gallons per day from its own treatment system. The company plans to recycle all of its own water and get as close as possible to a closed-water-loop system.

Smurfit Paper Company currently purchases water from the city of Pomona, but manages the wastewater and solid waste itself. After recycling the water several times, the plant's five primary effluent clarifiers remove most of the solids from the wastewater before discharging it to the sewer. It takes the solid waste (the sludge) and sends it through screw presses to remove the water, and then sends the waste to landfills. Smurfit management plans to sell the material as a soil amendment. This would help supplement costs.

**Source:**
***OWR News***, City of Los Angeles Office of Water Recycling, and David J. Lyons, Smurfit Newsprint Corporation, Pomona, California, 1992.

## Norton Grinds Waste Away

Norton Company in Worcester, Massachusetts employs 3,000 people and produces industrial ceramics and grinding wheels used in machine tooling operations. Water is used by the company to wash raw abrasive materials, to float out ultrafine particles, to mix with the product when making grinding wheels, and to cool equipment and the working space. Less than 5 percent of Norton's water use is for sanitary or domestic purposes.

The cooling system was the first target of the conservation program at Norton. Between 1979 and 1982, three cooling towers were installed to save water that previously had been discharged after being used in a once-through cooling cycle. The cooling towers enabled Norton to convert the cooling cycle to a closed-loop system where the water can be reused approximately 20 times. No water is directly discharged from the closed-loop system, and makeup water must be added to compensate for evaporation. An investment of $320,000 for the cooling towers resulted in savings of 152 million gallons per year.

Processes in other buildings were later hooked into the closed-loop system, using the cooling towers. There are five recirculating cooling systems dependent on the three cooling towers. Norton also reduced its dependency on the municipal water supply by sinking an on-site well. The cooling towers now use well water instead of municipal water for makeup, and some process cooling was converted to use well water.

Other conservation measures include changing some product washing operations to a dry process, installing thermal regulators on water-cooled equipment, and using low-flow showerheads. In an effort to make each division aware of the volume and expense of water used in their area, Norton implemented an internal charge-out system for municipal water. Continuous leak detection and repair is part of regular maintenance to reduce water waste.

Norton Company has practiced water conservation for the past 10 years and in doing so has cut water consumption by 60 percent. It has also cut operating costs by reducing water and sewer use, as well as reducing the discharge of heated effluent. The company indicated that cost increases in water, sewer, energy, and discharge permitting will likely lead to further conservation efforts.

**SOURCE:**
Massachusetts Water Resources Authority, Boston, Massachusetts.

## Ontario, Canada Greens Workplace

Located just an hour from Lake Ontario, it is hard to believe the Kitchener-Waterloo area in Ontario would ever experience a water shortage. However, wells have gone dry and restrictions on lawn watering and car washing are common in the summer months. Water consumption increased so much that the provincial government and municipalities are facing the possibilities of a new water treatment plant and pipes to carry water and sewage. To control this water consumption, the Ministry of Natural Resources announced in August 1991 a strategy to hold Ontario's water consumption to current levels until the year 2011.

The Ministry of Government Services has already made changes to manage water consumption at government facilities. It started with new approaches to landscaping in gardens. Secondly, washrooms in office buildings were retrofitted to demonstrate modern low-flow plumbing equipment.

The gardens feature drought-tolerant plants and an in-ground drip irrigation system. Each plant group is labeled so people can learn about it and know what to buy for their own garden. More paths and benches will be added to encourage people to wander around and use the garden. Government employees are even encouraged to pick the herbs grown there.

The source of water for the drip system is rainwater collected in large tanks. The underground system eliminates the need for watering the garden with potable water and cuts the moisture lost through evaporation that occurs while watering during the day.

Washrooms have been retrofitted with low-flush toilets (1.6 gallons or less per flush), computer controlled flushing of urinals, and flushometers that control the amount of water used in flushing. The faucets are operated by infra-red beams, and provide a measured amount of water when hands are placed under the tap. Each toilet replaced with the modern low-flush type can save enough water (over 3 gallons) to supply drinking water for four adults for one day. These conservation measures save water and reduce the amount of wastewater that must be cleaned.

By presenting demonstration projects at the provincial buildings, the Ministry of Government Services hopes to promote water conservation at work and at home.

**SOURCE:**
Brian Opitz, Ontario Ministry of Government Services Water Management Project, "Water Efficient Projects Conserve Precious Resource," **Spectrum**, 1992.

## Palo Alto Helps Ice Cream Plant and Pharmaceutical Company

The city of Palo Alto, California is a full service municipal utility. The Utilities Department, Energy Services Division, offers a variety of programs and services to assist customers in managing their utility costs. These include assignment of a utility resource advisor to provide customized technical assistance, consultant services, and equipment loans.

In September 1991, the city of Palo Alto introduced a pilot water efficiency program. The water efficiency program offered up to $10,000 per utility account for reductions in indoor uses for potable water supplied by Palo Alto. As part of the program, free water audits were offered to assess the potential for additional cost-effective water efficiency improvements in other business facilities.

There were three main objectives for the audits: (1) to evaluate the potential water conservation volume and associated cost for the city of Palo Alto, (2) to provide customers with an initial evaluation of specific conservation measures for their facilities, and (3) to gain insight regarding customer water quality needs.

The city invited high-water users with industrial process discharges to receive free indoor water audits. The city retained the services of a waste minimization expert to address the customers' process water quality needs. The audit team then met with facilities managers to describe the city's program and to learn about each customer's primary water-related concerns.

### Ice Cream Facility

In the first meeting with the plant manager, the audit team was asked to focus on reducing wastewater costs. Sewer-discharge costs had risen from $20,000 in 1989 to $70,000 in 1991, and were forecast to increase to $120,000 in 1992.

The audit correlated wastewater flows and loads to production operations. The results showed that most of the waste load was generated during cleaning of mix-preparation vats and storage tanks, rather than in the freezers and the packaging machines.

Daily meter readings at the beginning of the water audit helped identify leaks. These leaks were repaired quickly. Another very important result from the audit was the identification of several uncontrolled, once-through cooling loops that were contributing almost 55 percent of the wastewater volume. Closing these loops through the existing cooling towers could easily eliminate 90 percent of the waste, conserving 2.3 million gallons per year (gpy).

Clean-in-place (CIP) systems were identified to successfully reduce waste loads by 50-80 percent and allow the recovery of usable product. The following table shows that the largest savings from a combined CIP/recovery system at the ice-cream plant would be a reduction in organic loading. Recovery of cleaning chemicals would be the second largest savings.

**Savings from CIP/Recovery System for Ice Cream Plant**

| | 50% Recovery<br>3 million gpy<br>$1,000/year | 75% Recovery<br>3.4 million gpy<br>$1,000/year |
|---|---|---|
| Wastewater Organic Load | 47.3 | 70.9 |
| Water/Wastewater Flow | 11.8 | 13.3 |
| Cleaning Chemicals | 26.5 | 38.5 |
| Product Recovery | 12.0 | 18.0 |
| Total Savings | $97.6 | $140.7 |
| Installation Costs | $200,000-$300,000 | |

### Pharmaceutical Company

Prior to the audit team arrival, the facilities manager measured and identified the major water users and initiated a project to recirculate cooling water, which was the largest user. He requested that the city's audit team focus on an animal facility and a cream and lotion production process.

The pharmaceutical company has an animal research facility that keeps a variety of species in 170 rooms with cages. The cages were cleaned every day by a 15-person crew using “garden hose” spray guns. The flow rate through the guns was seven gallons per minute (gpm), for approximately 30 minutes in each room. Although the water temperature was set at 120$^{o}$F, the water ran cold after 45 minutes due to limited heater capacity (the gas burner operated at full rate, but could not meet the instantaneous demand for hot water).

Since the cleaning relies on impact to remove dried urine and feces, the audit team recommended replacing the existing spray guns with water-efficient models (2-3 gpm) that would also provide higher impact by concentrating the spray into a well-defined fan. Another possible alternative was to purchase 15 portable high-pressure, low-flow rinsers (1-2 gpm at 1,000 pounds per square inch) for each crew member to provide even higher impact.

Installing more efficient spray guns would save 9.3 million gpy of water, and 1,935 million Btu per year of gas together worth $27,400 per year. Installation costs are $17,000 which yield a payback period of 7.5 months.

The animal facility also had a large cage-washing machine, designed with both water and energy conservation features. Final rinse water replenished the first rinse, and provided makeup for the cleaning solution. Heat exchangers were used to recover heat from waste streams.

Even with these features, closer examination revealed conservation opportunities. Due to eroded and damaged spray nozzles, the measured flow rate was 40-80 gpm rather than the 16 gpm specified by the manufacturer. Replacing all the spray nozzles in the machine with new quick-change, positive-alignment nozzles meeting the manufacturer's original design would have a payback of less than one month. The new nozzles cost $16,300. Improved water efficiency saved 3.3 million gpy worth $6,600. Heat savings were 2,130 million Btu per year worth $9,700.

In the cream and lotion production plant, approximately 10,000 gpd of hot water—approximately half tap-water and half deionized water—are used for cleaning tanks and piping. The most obvious improvement was to install an automated clean-in-place system instead of the manual fill-and-dump procedures, which might reduce water consumption by 90 percent.

Unfortunately other operational issues made such a proposal infeasible: (1) Food and Drug Administration validation analyses would add at least $50,000 to the project; and (2) the deionized water system required additional storage capacity and pumps, for which the fire department had already requested major access modifications (for a previous capacity expansion plan to meet current levels of production), which could add approximately $100,000 to the project.

On the other hand, the reduction in demand for cleaning water could reduce the size of the tanks and pumps required for the expansion, eliminating the need for the fire-access modifications, and perhaps even a need for a contemplated plant relocation. As outsiders, the audit team was not privy to these considerations.

Several less-intrusive measures were identified to reduce water consumption by approximately 50 percent:

- Provide extension lances, rotary nozzles, and a booster pump for high-pressure, low-volume spray cleaning of tanks. Besides reducing the volume of water used during spray cleaning (and over-spraying onto the floor), effective spray rinsing could replace at least 1 fill and dump cleaning cycle (approximately 1,500 gpd of deionized water).

- Replace all spray nozzles in the parts washer with new quick-change, positive-alignment nozzles.

The total potential savings, was $10,300 per year at an installation cost of $5,000.

**<u>SOURCE</u>**:
***Audit Results from the City of Palo Alto's Water Efficiency Program for Industry***, by Virginia Waik, City of Palo Alto Utilities, Energy Services Division, P. O. Box 10250, Palo Alto, California, 94303, and John Rosenblum, Ph.D., Rosenblum Environmental Engineering, 3502 Thorn Road, Sebastopol, California, 95472. Reprinted with permission.

## Pepsi-Cola Bottling of Ventura

In 1991, the city of Ventura, California provided a consultant to help major business customers reduce their operating costs. The consultant provided on site surveys to identify efficiency measures. The focus was to improve water use efficiency, improve energy efficiency and reduce wastewater discharge.

The Pepsi-Cola Bottling of Ventura produces Pepsi-Cola and other carbonated soft drinks, bottled in cans and bottles, as well as tanks of concentrated product formula.

All water used at the plant was purchased from the city at the rate of $2.142 per hundred cubic feet, or $2.86 per thousand gallons. Wastewater charges averaged $11.28 per thousand gallons due to the high concentrations of biochemical oxygen demand from sugars in the wastewater.

The plant's average water consumption was more than 67,000 gallons per work day (gpwd). If all of the recommendations were implemented, the savings would be more than 4.5 million gallons of water per year, approximately 92,000 kilowatt hours of electricity per year, and 11,000 therms of natural gas per year. The savings were worth more than $18,860 due to decreased water and wastewater volume, $6,660 from biochemical oxygen demand reductions, $1,500 in reduced chemical consumption, and $14,740 from energy conservation. The total savings were $41,760.

The major water uses and measures to achieve these savings are described below.

***Purification of Water Recovery***—Approximately 500 gpwd of slurry was discharged, and a total of 1,000 gpwd of water was consumed in the purification process. The recommendation for water and wastewater efficiency was:

- Provide a second clarifier to recover water from the slurry and also provide a Granular Activated Carbon (GAC) filter backwash. The solids withdrawn would be barreled for disposal as solid waste, and all of the water from the GAC filter would be recovered. Capital cost of the slurry treatment system and GAC filter system would be approximately $9,000. Operation of the slurry transfer pump would require about 3 kilowatt hours of electricity, which would cost $4 per year. Equipment maintenance costs requirements would average about $100 per year. Solid waste charges (13,000 pounds per year at $0.51 per pound) would be $6,600. Potential water/sewage savings averaged 156,400 gallons per year. With all costs considered, including the different sewage rates and less water usage, the total savings would be more than $7,000 per year. This would have a payback period of 1.3 years.

***Vacuum Pump Water Recycling***—Total water consumption was 7,800 gpwd. The recommendation for water efficiency was:

- Catch wastewater and pump it to the flocculating clarifier. Capital cost would be approximately $500. Potentially over 1.6 million gallons per year would be saved, worth $6,200. The payback period would be 0.1 year.

***Bleed-Off from Evaporative Condensers***—About 23,000 gpwd was bled from the evaporative condensers to prevent a buildup of salts in the water. The average concentration ratio was 1.65. The recommendation for water efficiency was:

- Change the concentration ratio to 3, and reduce bleed-off to 4,500 gpwd, worth $7,450 per year. Chemical savings would average approximately $1,500 per year. The capital cost would be $2,000 to keep the pH level. The payback period would be 0.2 year.

***Washer Spray Control***—The amount of water consumed in washing cans, trays, and bottles could be reduced by installing a switch to run the water spray for washing only during production. This has a potential savings of more than 88,000 gallons per year, worth $330. The payback period would be 1.2 years.

***$CO_2$ Pipe Thaw***—Replace the hot water used to keep CO2 pipes from freezing with heat tape to potentially save $1,040 of water/wastewater and $1,560 of energy. With a capital cost of approximately $400, the total savings would be $2,600 per year. This has a payback period of 0.2 year.

***Pump Seal Water Recovery***—Three hundred gpwd of water was used to seal pumps in the bottle filling room. By collecting and sending this water to the condensers, approximately 1,200 gpwd would be saved, worth $960 per year. The capital cost for this would be about $750 giving a payback period of 0.8 year.

***High-Pressure Hose Nozzles***—Replacement of regular hoses with high-pressure nozzles would reduce the current use of 2,400 gpwd by one-third. The capital cost would approximately be $450, giving a short payback period of 0.7 year.

**SOURCE:**
***Water/Energy Conservation Study***—Pepsi-Cola Bottling of Ventura, Black & Veatch for the City of Ventura, California, May 1992.

## Positive Cash Flow Financing

Many government agencies and institutions have experienced severe budget cuts in the past few years. As a result, they do not have funds to implement conservation measures which are cost effective.

Many times installing more efficient equipment results in financial savings, but money to replace existing equipment is unavailable.

Several innovative funding options are available to fund water and/or energy saving projects that would otherwise go undone due to tight budgeting. Each option employs an outside financing agent or investor. The expenses budgeted for the water and energy are predetermined. The savings generated from conservation would provide the funds to payback the investors.

Local residents, businesses, and all members of the community would benefit directly from the institution's action on water conservation by the immediate reduction in use of water and energy and future reduction in operating expenses.

The key to obtain these benefits is to develop the most effective financing method for both the institution and investor. Payments for these services are based on a negotiated split of the actual cost savings from water, sewer, and associated energy reductions.

The Positive Cash Flow Financing program would offer four basic types of funding.

1. **Finance lease**— The lessee makes a firm commitment for a fixed number of payments.

2. **Municipal lease**— This is a conditional sales contract or installment purchase contract. A predetermined lease payment is setup with clear principal and interest components. Ownership would pass to the lessee.

3. **Guaranteed savings program**— The savings in reduced utility costs and all expenses would pay for the project. The end-user would share the net savings.

4. **Shared savings plan**— The split of the savings is predetermined. No cash investment is required by the user. The savings are used to pay the debt.

The idea of third-party financing provides another option for the institutional sector. By sharing the utility cost savings generated, the third-party source assumes the debt obligation along with the engineering and financial risks.

Any of these options could save millions of dollars in direct costs to schools and institutions, so whole communities would benefit. Development through this kind of public/private partnership resolves some of the financial problems for institutions when trying to meet the present conservation standards.

**SOURCE:**

David Horne, Wendy Corpening, "Positive Cash Flow Financing," ***Water Conservation News***, DWR, January 1992. Conservation Solutions, 725 Arizona Avenue, Suite 206, Santa Monica, California, 90401; (310) 395-6767.

## Restaurant Efficiency Methods

Water is a significant part of the restaurant service. It is used for cooking, cleaning, food production, customer consumption, and sometimes for landscaping. Therefore, efficiency is important to keep costs down.

Here are some examples of how restaurants have become more water efficient across the United States.

### Seattle, Washington

A survey sponsored by the Seattle Water Department in March 1990 noted the major water uses in restaurants were dish washing, ice-making, and plumbing fixtures. Thirty-seven percent of restaurant owners agreed that water and sewer costs were significant. The recommendations to increase water efficiency were:

- Smaller restaurants without automatic dishwashers should presoak and wash larger loads rather than one piece at a time. Also use low-flow faucets and repair any leaks.

- Operate ice machines correctly to maintain efficiency. Make sure the valves controlling condenser cooling water are operating properly.

- Install a displacement dam or bag in each toilet and/or replace with 1.6-gallons-per-flush toilets; install restrictors and/or low-flow faucets. By just changing to 1.6-gallons-per-flush toilets, the restaurant would reduce water use by 36 percent.

- Increase employee awareness and efficiency, and improve maintenance of both equipment and water support systems.

- Health Codes may limit reuse of water. One option is to route sanitized rinse water back to the next wash cycle or to the garbage disposal.

### Los Angeles, California

In February 1971, on-site surveys done by the consultants for the Los Angeles Department of Water and Power made recommendations to two restaurants:

- El Cholo Restaurant serves 900 meals a day. Restaurant employees could reduce the prewash time before putting dishes into the dishwasher. This would save 142,000 gallons per year, with cost of water at $3.18 per thousand gallons worth $450 annually. The payback period would be immediate.

- Little Joe's Restaurant serves over 700 meals per day. Restaurant employees could eliminate the automatic prewash sprayer on the dish washing system and install a manual hand sprayer. This would save 734,000 gallons per year, with the cost of water at $3.18 per thousand gallons, worth $2,330. The capital cost would be $400; the payback period would be 0.2 year.

## Phoenix, Arizona

In 1991, the city of Phoenix published a ***Water Conservation Guide for Restaurants*** suggesting cost-effective water savings. The recommendations were:

- Operate dishwasher equipment properly—this is critical. Run full loads, and limit water flow rate within the equipment. Reuse the final rinse for prewashes, garbage disposal, or food scraper. Stop the water in the conveyor-type dishwasher when the dishes are not present.

- Eliminate the garbage disposal. Since garbage disposals require frequent repair, eliminating them would also reduce maintenance costs. By replacing disposals with a garbage strainer and rinsing the garbage with recycled water, the business would reduce water use about 3 to 6 gallons per minute.

## Brockton, Massachusetts

In 1989, the Tip Top Restaurant in Brockton implemented the suggestions very quickly due to a severe drought and experienced immediate savings in both water and wastewater fees. The actions taken were:

- Installed automatic shutoffs on water faucet's in restrooms.

- Switched to tankless toilets.

- Installed an automatic shutoff conveyor system on the dishwasher.

- Installed water restrictors on all other faucets.

- Posted signs for customers and employees to conserve water.

By following the recommendations, the Tip Top Restaurant saved 60,000 cubic feet of water per year, a 30-percent decrease in the consumption rate, worth $300. The financial savings would have been higher but water rates and sewer costs rose considerably due to the urgency of water conservation. Even with increased rates, the payback period for all these changes was 0.8 year.

**SOURCES:**

***Water Conservation Guide for Restaurants***, prepared by Black & Veatch for the City of Phoenix, Arizona, 1991.

***Opportunities for Water Conservation in Seattle's Restaurant and Shipbuilding Sectors***, prepared by Synergic Resources Corporation for the Seattle Water Department, May 1990.

***Water Conservation Report—El Cholo Restaurant, and Water Conservation Report— Little Joe's Restaurant***, prepared by Black & Veatch for the City of Los Angeles Department of Water and Power, February 1991.

Massachusetts Water Resources Authority, Boston, Massachusetts.

## Supermarkets Improve Water Efficiency

### Boys Market

Employs approximately 90 employees and operates between 6 a.m. and 2 a.m. daily. The sales floor is approximately 30,000 square feet.

The market purchased all of their water from the City of Los Angeles at the rate $3.67 per 1,000 gallons. The market's annual water consumption was 3.2 million gallons, costing $11,745.

The following areas describe the recommendations made based on the information gathered from the water use inventory, the process that identifies the quantities, characteristics, and uses of all water on the site:

***Evaporative Condenser*** —The total daily evaporation was approximately 2,810 gallons, operating with a concentration ratio of 2.0. This was 60 percent of the market's total daily water consumption. The recommendation was:

- Operate the tower at 3.0 cycles of concentration. Potential savings would be 514,650 gallons per year, worth $1,890 a year. In addition the market would save $400 per year in chemical costs. Total savings for the year would be $2,290; since there were no capital costs, the payback would be immediate.

***Restrooms***—The market had four restrooms for employee use and no public restrooms. The total daily consumption with faucet and toilet use was 620 gallons, approximately 6 percent of total daily water consumption. The recommendations were:

- Install flow restrictors or low-flow faucet aerators to limit water flow to a maximum of 1.5 gpm. Potential savings would be 40,150 gallons per year, worth $147 annually. The capitol cost would be $25; the payback period would be 2 months.

- Install 1.6 gallons-per-flush toilets to reduce flush volume by 1.0 gallons. Potential savings would be 54,750 gallons per year, worth $200 annually. The capitol cost would be $500 (this includes a $100 rebate per toilet.); the payback period would be 2.5 years.

***Bottle Water Vending Machine***—An outside company owned and operated two water filtration vending machines located in front of the store, but the market provided the water. Total estimated daily water consumption was 800 gallons per day. The recommendation was:

- Route the discharge from the vending machines to the evaporative condenser. Potential savings would be 600 gallons per day or 219,000 gallons annually, worth $804. The capitol cost would be $500; the payback period would be 0.6 year.

### Major Supermarket

Employs 200 people and operates twenty-four hours a day. The store size is approximately 50,000 square feet.

The market purchased their water from the City of Los Angeles at the rate of $3.67 per 1,000 gallons. The annual water consumption was 6.2 million gallons costing $22,754.

The following areas describe the recommendations made based on the information gathered from the water use inventory, the process that identifies the quantities, characteristics, and uses of all water on the site:

***Evaporative Condenser***—The total daily consumption was approximately 8,655 gallons, operating with a concentration ratio of 2.5. This was 50 percent of the market's total daily water consumption. The recommendation was:

- Operate the tower at 3.0 cycles of concentration to save approximately 880 gallons per day or 321,200 gallons per year, worth $1,178. This would also have an additional chemical savings of $400 per year. The total savings would be $1,578 per year. With no capital costs, the payback would be immediate.

***Restrooms***—The market had two restrooms for employee use and no public restrooms. The total daily consumption with faucet and toilet use was 1,330 gallons, approximately 7 percent of total daily water consumption. The recommendations were:

- Install flow restrictors or low flow faucet aerators to limit water flow to a maximum of 1.5 gpm. Potential savings would be 47,000 gallons per year, worth $175 annually. The capitol cost would be $25; the payback period would be 0.1 year.

- Install 1.6 gallons-per-flush toilets to reduce water flush volume by 1.0 gallons. Potential savings would be 151,475 gallons per year, worth $555 annually. The capitol cost would be $300 (this includes $100 rebate per toilet.); the payback period would be 0.5 years.

***Garbage Disposal***—At the time of the audit, water flow to the produce garbage disposal failed to stop when the disposal was not in use. This problem cost an estimated 2,880 gallons of water a day with a potential cost of $3,860 per year. Repairing the flow valve to the disposal as quickly as possible would lead to substantial savings.

**SOURCES:**
***Water Conservation Report—Boys Market*** *and* ***Water Conservation Report—Major Supermarket***, prepared by Black & Veatch for the City of Los Angeles Department of Water and Power, February 1991.

## Toyota Motor Manufacturing

Toyota Motor Manufacturing USA, Inc. (TMM) manufactures Toyota automobiles at Georgetown, Kentucky. The plant is attempting to improve water efficiency by approximately 87 million gallons per year.

Some of the modifications to achieve these savings are described below.

***Steam condensate recovery***—Approximately 40 percent of the steam uses are indirect steam which can be recovered for use as boiler feed water. TMM is currently recovering only 20 percent.

- Plans are to recover 35 percent by the end of 1993. The estimated water savings by 1994 is 8.5 million gallons per year.

***Deionized water***—TMM uses a wet sand process which requires deionized water. Past practice has been to send the used deionized water to waste treatment.

- A recycle system is being designed to reuse all of the deionized water. The estimated water savings is 59.4 million gallons per year.

***Assembly shower test***—The test stand sprays water on new cars for a final leak test. The water is captured in a 15,000-gallon pit and recirculated; however, the water picks up trace contaminants of oil and dust. This requires a 40-gpm water blowdown and makeup to keep water fresh.

- Over the July shutdown, TMM will install an ultraviolet sanitizer which will save 30 gpm of makeup water. The estimated water savings is 15.7 million gallons per year.

***Boilers***—They required a release of water called "blowdown" to maintain boiler water chemistry at a specific control set point.

- Existing set points could be adjusted along with additional controls to reduce blowdown by approximately 2.3 million gallons per year.

Direct steam injection—temperatures of processes have been controlled by injecting steam into the process.

- Using heat exchangers allows recovery of this water. The estimated water savings is 500,000 gallons per year.

***Deaeration***—This equipment uses live low-pressure steam, vented to the atmosphere.

- Installing new control valves and reducing pressure will reduce steam use by 23,000 pounds per day, which requires 19,000 pounds per day of fresh water makeup. The estimated water savings is 830,000 gallons per year.

**SOURCE:**
Information provided by Rick Lancaster, Facilities Engineering, and Alice Woosley, Environmental Department, Toyota Motor Manufacturing USA, Inc., Georgetown, Kentucky, May 1993.

## Ventura Coastal Citrus Processor

In 1991, the city of Ventura provided a consultant to help major business customers reduce their operating costs. The consultant provided on-site surveys to identify efficiency measures. The focus was to improve water use efficiency, improve energy efficiency, and reduce wastewater discharge.

The Ventura Coastal Plant processes citrus fruit to produce a variety of products including frozen juice concentrate, citrus oils, animal feeds, and dried peel. The plant's basic process involves receiving fruit by truck, washing the fruit, extracting juice, separating peel and pulp, concentrating and freezing juice, refining oils, and processing pulp and residual peel solids. The plant also prepares juice products by blending juices and other ingredients prepared elsewhere.

All water used at the plant was purchased from the city at the rate of $1.278 per hundred cubic feet (ccf) or $1.71 per thousand gallons. Wastewater charges were $1.47 per ccf or $1.96 per thousand gallons.

Average water consumption was about 112,450 gallons per day. If all of the efficiency measures recommended in the survey were implemented, the water/wastewater costs would be reduced by more than 2.5 million gallons per year, worth $9,210, and energy costs would be reduced by $8,300. These savings, with other cost reductions, would yield a net savings of $19,510 per year.

The major water uses and measures to achieve these savings are described below.

***Fruit washing***—Approximately 5,500 gallons of water per day was used cleaning the fruit for processing. The recommendation for water efficiency was:

- Reduce the flow of water used to wash the fruit. Potential savings would be 950 gallons per day, worth $1,270. Because of the minimal cost, the calculated payback period would be immediate.

***Evaporators***—Juice was concentrated by three evaporators. Evaporators took the water removed from the fruit and mixed it with condensed steam. The combined total discharge was 35 gallons per minute of condensate. Together the steam condensate and water from the fruit amounted to approximately 30,000 gallons per day. The recommendation to use the resultant mix was:

- Install a reverse osmosis treatment to purify the water system. Potential savings would be 27,000 gallons per day, with a net value of $31,020. The capitol costs would be $134,000. The payback period would be 4.3 years, which was too long for the measure to be recommended at this time.

***Evaporative condensers and cooling towers***—Ten evaporative coolers and cooling towers served evaporators, hydraulic systems, and the ammonia refrigeration system. Total water use for this was approximately 31,000 gallons per day. The recommendation for water efficiency was:

- Increase the concentration ratio to 5 by decreasing bleed-off by 50 percent, a savings of almost 5,200 gallons per day, worth $6,940 per year. The capital cost would be $5,000 for a payback period of 0.6 year.

***Steam and refrigerant piping insulation***—Approximately 500 feet of steam pipe and 500 feet of refrigerant pipe needed insulation. Potential savings would be 19 therms per foot, with a net savings of $6,860. The payback period would be 0.6 year.

***Domestic***—Low-flow aerators would save approximately 71 percent of the 1,050 gallons per day used by faucets. Potential savings would be $1,310 per year and a cost of $100 for a payback period of 0.1 year.

**SOURCE:**
***Water/Energy Conservation Study—Ventura Coastal Corporation****,* Black & Veatch for the City of Ventura, California, May 1992.

# Chapter 5: Responses that Businesses Can Use for Water Shortages

## Overview

Experience shows that industrial water users respond to water conservation programs in emergency situations. One example is the experience of the East Bay Municipal Utility District, which serves Oakland and its neighbors. EBMUD experienced a 28-percent reduction in water use from its industrial customers during the 1988 drought management program. Only a 9-percent reduction from 1987 use had been expected by the utility. In 1989, industrial users sustained a 26-percent cutback even though EBMUD sought only a 5-percent reduction from 1987 levels.

The likelihood of water shortages occurring in drought-afflicted areas is obvious, but water shortages are also possible in historically water-rich areas. Unexpected shortages can occur due to many causes. Hurricanes, snowstorms, floods, or earthquakes can disrupt power supplies used to pump water. Water mains break. Chemical spills, ground water pollution, or contamination of reservoirs and rivers may make supplies unusable. Preparing for such contingencies can mean the difference between continued production and plant shutdown.

## Preparing for Water Shortages

Planning for water shortages can help to avoid loss of production, reduced operating hours, and employee layoffs. Some of the planning elements are:

1. Know how much water is really needed to operate. What would be the effect of a 10, 15, or 25 percent reduction in delivered water?

2. Establish a baseline measure of water use per unit of production. This will provide a measure of overall plant water use efficiency.

3. Identify water uses that can be suspended during the shortage, such as:

    - Landscapes that can survive with less water.

    - Less frequent vehicle washing.

4. Develop contacts with water and wastewater utility management so they are aware of your capabilities and needs in advance:

    - Manufacturers should play an equitable role in mandated water rationing plans.

    - Develop a plan for decreasing water uses similar to electrical power load shedding.

- Know what the impacts will be to wastewater discharges. Coordinate with wastewater regulators for temporary waivers during the shortage.

- Credit should be claimed by water users who have already implemented water conservation measures and become water efficient. These water users should not be penalized by new water use constraints.

5. Identify alternative sources of water supplies. Identify how the water will be transported to the site. Since this water is likely to be of different quality than the regular supply, determine how it can be used.

6. Evaluate the cost (particularly during extended droughts) of water shortage measures at increased water rates (see **Sample Water Allocation Notice** on page 80).

7. Develop a program to communicate with employees the seriousness of the shortage. It should include:

   - Establish a system for employees to notify maintenance staff about leaks, drippy faucets, broken sprinklers, or other occurrences of water waste.

   - Post water conservation stickers and signs in bathrooms, kitchens, and cafeterias. Learn where to obtain these materials in advance.

   - Promote slogan and poster contests in conjunction with the local water utility. Display the best slogans and posters at areas of heavy water use.

   - Compare graphic displays of the facility's actual water use results with the objective for each week or month.

8. Prepare sample press releases to inform the public of your water conservation efforts.

### Increased Utility Fees to Cover Fixed Costs

Reduced utility revenues are likely due to decreased water sales during a drought. The utilities are likely to increase fees to cover fixed costs of operations.

These increased fees make inefficient water use expensive. The **Sample Water Allocation Notice** shows a hypothetical projection of the annual fees charged to a large water user during a drought. Prompt implementation of water conservation measures would reduce these fees, thereby offsetting the cost of some conservation measures. Sewage fees are often greater than water rates. Aggressive water conservation efforts may also reduce sewage, pretreatment, and energy costs.

## Sample Water Allocation Notice

| | Base Use 1,000 gal | Conserve Goal % | 1991 Allocation Amount 1,000 gal | 1991 Allocation Bill $ | Excessive Use Amount 1,000 gal | Excessive Use Bill $ | Total Bill $ |
|---|---|---|---|---|---|---|---|
| Month | | | | | | | |
| Jan | 10,000 | 0 | 10,000 | 10,000 | 0 | 0 | 10,000 |
| Feb | 10,000 | 0 | 10,000 | 10,000 | 0 | 0 | 10,000 |
| Mar | 10,000 | 0 | 10,000 | 10,000 | 0 | 0 | 10,000 |
| April | 12,000 | 20 | 9,600 | 14,400 | 2,400 | 7,200 | 21,600 |
| May | 14,000 | 25 | 10,500 | 15,750 | 3,500 | 10,500 | 26,250 |
| June | 14,000 | 30 | 9,800 | 14,700 | 4,200 | 12,600 | 27,300 |
| July | 16,000 | 35 | 10,400 | 15,600 | 5,600 | 16,800 | 32,400 |
| Aug | 18,000 | 35 | 11,700 | 17,550 | 6,300 | 18,900 | 36,450 |
| Sept | 17,000 | 35 | 11,050 | 16,575 | 5,950 | 17,850 | 34,425 |
| Oct | 19,000 | 35 | 12,350 | 18,525 | 6,650 | 19,950 | 38,475 |
| Nov | 10,000 | 35 | 6,500 | 9,750 | 3,500 | 10,500 | 20,250 |
| Dec | 10,000 | 35 | 6,500 | 9,750 | 3,500 | 10,500 | 20,250 |
| TOTAL | *160,000 | | **118,400 | **$162,600** | 41,600 | **$124,800** | **$287,400** |

**Notes**:

1. For this water shortage, the target reduction is 25 percent of the annual water consumption.
2. For the sample water allocation notice above:
   a. the old rate was $1.00 per 1,000 gallons
   b. the new rate became effective April 1 and is $1.50 per 1,000 gallons
   c. the excessive use rate is $3.00 per 1,000 gallons over the allotted amount.

* base year billing $160,000

** provides annual use of 74 percent of base year

## Actions to Conserve Water During Shortages

### Important Management Actions

1. Implement the Water Shortage Contingency Plan.

2. Establish priorities and quantitative goals for water use.

3. Read water meters at least once each week to compare actual use with goals and allocations.

4. Ask wastewater regulators to recognize drought restrictions on water use by temporarily amending your wastewater discharge permit to permit higher concentration levels of effluent at lower flows.

### Water Conservation Measures

1. Fix all leaks.

2. Recheck all water uses to be sure that they occur only when actually needed.

3. Reduce or eliminate landscape irrigation.

4. Reduce vehicle washing.

5. Substitute broom sweeping, or mop and bucket cleaning of floors for hose wash downs.

6. Turn off decorative fountains. If they use treated wastewater, continue the use with signs notifying the public of the source of the water.

7. Review Chapter 3 for an extensive list of water efficiency measures.

8. Implement planned water efficiency measures ahead of schedule.

9. Obtain water from sources unaffected by the water shortage, such as:

    - Treated municipal or industrial wastewater.

    - Tainted ground water being pumped and treated for ground water cleanup.

# Appendix A

## How to Read Your Water Meter

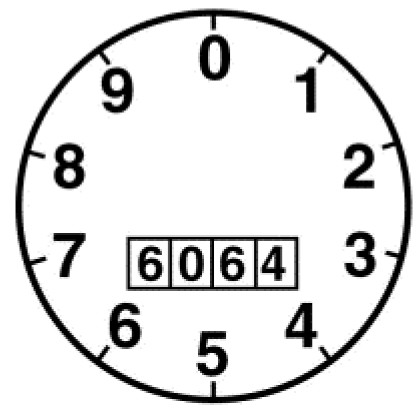
If you want to track your water use more often than monthly with your utilities bill, you can read your own meter. It may seem a little complicated, but with the following instructions, you'll be able to do it.

### Location of your water meter

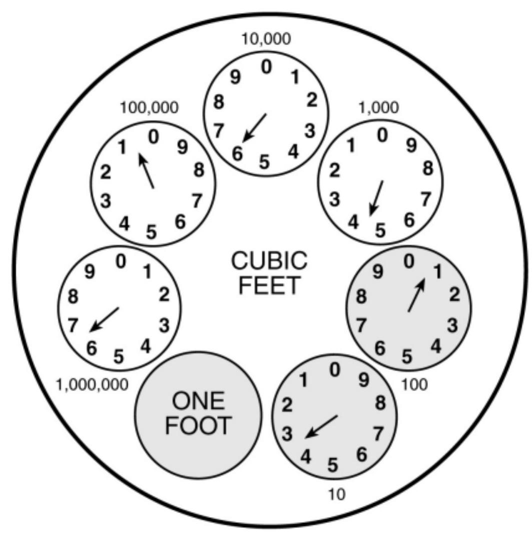
Generally, water meters are enclosed in a concrete box which is buried near the front of your property. The box is usually underground with only a rectangular concrete lid visible. Remove the concrete lid carefully to avoid injury and set it aside. You are now ready to read your meter.

### Reading your meter

Typically, there are two kinds of meters. Refer to the illustrations to find your meter type.




Straight-Reading Meter: The straight-reading meter reads exactly like the mileage indicator on your car. Ignore the needle as shown in the illustration--it isused for testing purposes only. The illustration shows 6064, which is the total number of hundred cubic feet units (ccf) of water recorded since the meter was installed. If you read the meter a month later and it shows 6164, simply subtract the old reading from the new one (6164-6064). This shows that you used 100 units of water during that period. Note: meter units may differ, gallons, cubic feet, hundreds of cubic feet (ccf).




Round-Reading Meter: The round-reading meter has several small dials in a circle. Each reads like a clock, except that the hand on every other dial turns counter clockwise. To read this type of meter, just start at the right and write down the reading of each dial from right to left. (When any hand is between numbers, always use the lower number). These dials register 6, 0, 6 and 4.

Disregard any dials (shaded in illustration) with numbers of 100 or less. The 100 and 10 unit dials record water in units smaller than what is reported on your utilities bill. The "ONE FOOT" dial is the test dial to show that your meter is working.

## Appendix A

**How to Read Your Water Meter (continued)**

**Determine Your Use**

Once you can read your meter, you can then determine your water use over time. Two meter readings are necessary.

1. Take two meter readings. For example:

   a. Recall last reading from illustration = 6064
   b. Suppose current reading = 6164

2. Subtract the last reading from the current reading. For example:

| | | |
|---|---|---|
| a. | Take current reading: | 6164 ccf |
| b. | Subtract last reading: | <u>6064 ccf</u> |
| c. | Total usage for period | 100 ccf |

### Convert Cubic Feet into Gallons

There are 748 gallons per 100 cubic feet of water.

Multiply ccf by 748 to get the number of gallons used. For example:

100 ccf x 748 gallons/ccf = 74,800 gallons

# Appendix B

## Water Usage Chart

| Equipment | Location | Flow Rate (gallons/minute) | Comments |
|---|---|---|---|
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# Appendix C

## Water Efficiency Standards for Plumbing Fixtures and Fittings Required by the Energy Policy Act of 1992

The maximum water use allowed for any showerhead manufactured after January 1, 1994 is 2.5 gallons per minute when measured at a flowing water pressure of 80 pounds per square inch.

The maximum water use allowed for any of the following faucets manufactured after January 1, 1994, when measured at a flowing water pressure of 80 pounds per square inch. Is as follows:

- lavatory faucets — 2.5 gallons per minute
- lavatory replacement aerators — 2.5 gallons per minute
- kitchen faucets — 2.5 gallons per minute
- kitchen replacement aerators — 2.5 gallons per minute
- metering faucets — 0.25 gallons per cycle

The maximum water use allowed in gallons per flush for any of the following water closets manufactured after January 1, 1994, as follows:

- gravity tank-type toilets — 1.6 gallons per flush
- flushometer tank toilets — 1.6 gallons per flush
- electromechanical hydraulic toilets — 1.6 gallons per flush
- blowout toilets — 1.6 gallons per flush

The maximum water use allowed for any gravity tank-type white 2-piece toilet which bears an adhesive label conspicuous upon installation consisting of the words 'Commercial Use Only' manufactured after January 1, 1994, and before January 1, 1997, is 3.5 gallons per flush.

The maximum water use allowed for flushometer valve toilets, other than blowout toilets, manufactured after January 1, 1997, is 1.6 gallons per flush.

The maximum water use allowed for any urinal manufactured after January 1, 1994, is 1.0 gallon per flush.

# Appendix D

## Water Efficiency Actions for Federal Facilities Required by the Energy Policy Act of 1992

The purpose of the Energy Policy Act of 1992 is amended to include " and water, and the use of renewable energy sources".

Not later than January 1, 2005, each agency shall, to the maximum extent practicable, install in federal buildings owned by the United States all energy and water conservation measures with payback periods of less than 10 years;

Use surveys to determine the cost and payback period of energy and water conservation measures likely to achieve the requirements of this section; and

Install energy and water conservation measures that will achieve the requirements of this section through methods and procedures established pursuant to section 544.

Utility Incentive Program:

(1) Agencies are authorized and encouraged to participate in programs to increase energy efficiency and for water conservation or the management of electricity demand conducted by gas, water, or electric utilities and generally available to customers of such utilities.

(2) Each agency may accept any financial incentive, goods, or services generally available from any such utility, to increase energy efficiency or to conserve water or manage electricity demand.

(3) Each agency is encouraged to enter into negotiations with electric, water, and gas utilities to design cost-effective demand management and conservation incentive programs to address the unique needs of facilities utilized by such agency.

(4) If an agency satisfies the criteria, which generally apply to other customers of a utility incentive program, such agency may not be denied collection of rebates or other incentives.

(5) An amount equal to fifty percent of the energy and water cost savings realized by an agency (other than the Department of Defense) with respect to funds appropriated after fiscal year 1992 (including financial benefits resulting from energy savings performance contracts under title VIII and utility energy efficiency rebates) shall, subject to appropriation, remain available for expenditure for additional energy efficiency measures which may include related employee incentive programs, particularly at those facilities at which energy savings were achieved.

# Appendix E

**Publications Distributed by the California Department of Water Resources for Industrial, Commercial, and Institutional Water Conservation Revised 2000**

To obtain any of the following free publications, simply print this page, check the line preceding the one(s) you want and mail it to:

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____ **Water Audit and Leak Detection Guidebook**

____ **Water Audit Workbook v. 2.0, 2000 on diskette**

____ **Case Studies of Industrial Water Conservation in the San Jose Area**

____ **Helping Businesses Manage Water Use—A Guide For Water Utilities by AWWA, distributed by DWR only in California**

____ **Set of 4: Industrial Water Conservation References for...**

- ____ **Electroplating**
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You may also call (916) 653-1097 to obtain these publications.

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## Key Word Listing